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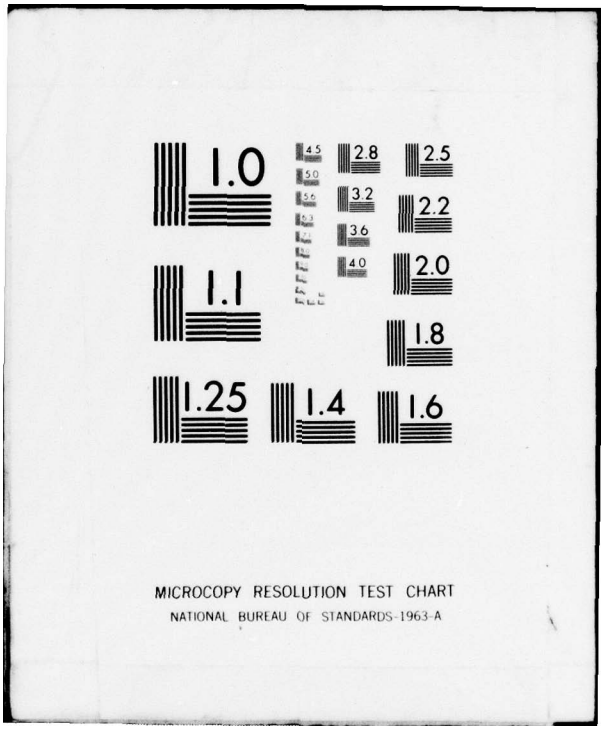
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DREDGED MATERIAL RESEARCH PROGRAM

Technical Report D-77-38

HABITAT DEVELOPMENT FIELD INVESTIGATIONS, MILLER SANDS MARSH AND UPLAND HABITAT DEVELOPMENT SITE COLUMBIA RIVER, OREGON

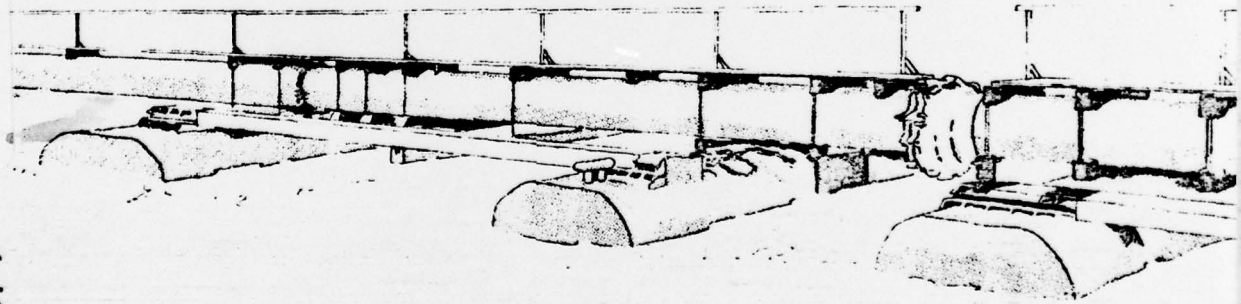
APPENDIX C: INVENTORY AND ASSESSMENT OF PREPROPAGATION TERRESTRIAL RESOURCES ON DREDGED MATERIAL

by

C. David White, Donald O. McKay, Alan D. Grant

Woodward-Clyde Consultants
San Diego, California 92110

March 1978
Final Report



Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

Under Contract No. DACW57-75-C-0247
(DMRP Work Unit No. 4B05D)

Monitored by Environmental Effects Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Mississippi 39180

HABITAT DEVELOPMENT FIELD INVESTIGATIONS, MILLER SANDS MARSH AND UPLAND HABITAT DEVELOPMENT SITE, COLUMBIA RIVER, OREGON

Appendix A: Inventory and Assessment of Predisposal Physical and Chemical Conditions

Appendix B: Inventory and Assessment of Predisposal and Postdisposal Aquatic Habitats

Appendix C: Inventory and Assessment of Prepropagation Terrestrial Resources on Dredged Material

Appendix D: Propagation of Vascular Plants on Dredged Material in Wetland and Upland Habitats

Appendix E: Postpropagation Assessment of Botanical and Soil Resources on Dredged Material

Appendix F: Postpropagation Assessment of Wildlife Resources on Dredged Material

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESYV

31 May 1978

SUBJECT: Transmittal of Technical Report D-77-38, Appendix C

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of Work Unit 4B05D regarding an inventory of prepropagation terrestrial resources at the Miller Sands Marsh and Upland Habitat Development Site, Columbia River, Oregon. This work unit was conducted as part of Task 4B (Terrestrial Habitat Development) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 4B is part of the Habitat Development Project (HDP) and has as its objective the development and application of habitat management methodologies on upland disposal areas for purposes of planned habitat creation, reclamation, and mitigation.

2. This report, "Appendix C: Inventory and Assessment of Prepropagation Terrestrial Resources on Dredged Material," is one of six contractor-prepared appendices published relative to Waterways Experiment Station Technical Report D-77-38, entitled "Habitat Development Field Investigations, Miller Sands Marsh and Upland Habitat Development Site, Columbia River, Oregon; Summary Report (4B05M)." The appendices to the summary report involve studies that provide technical background and supporting data and may or may not represent discrete research products. Appendices that are largely data tabulations or that clearly have only site-specific relevance are published as microfiche; those with more general application are published as printed reports.

3. The purpose of this report (4B05D) was to document the terrestrial ecology of Miller Sands Island prior to the implementation of habitat development activities. The study indicated that succession from open grasslands to a woody community was in progress on the island. With the exception of nutria and a largely transient bird population, the island had low and poorly represented animal populations.

WESYV 31 May 1978
SUBJECT: Transmittal of Technical Report D-77-38, Appendix C

4. Data from this report are best interpreted in the context of the series of 13 work units that were conducted at Miller Sands (4B05A-N) and are synthesized in that site's summary report (4B05M).

JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Report D-77-38
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): HABITAT DEVELOPMENT FIELD INVESTIGATIONS, MILLER SANDS MARSH AND UPLAND HABITAT DEVELOPMENT SITE, COLUMBIA RIVER, OREGON. Appendix C: Inventory and Assessment of Prepropagation Terrestrial Resources on Dredged Material

5. TYPE OF REPORT & PERIOD COVERED: Final Report

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): C. David White, Donald O. McKay, Alan D. Grant

8. CONTRACT OR GRANT NUMBER(s): DACW57-75-C-0247

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Woodward-Clyde Consultants, San Diego, California 92110

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Work Unit 4B05D

11. CONTROLLING OFFICE NAME AND ADDRESS: Office, Chief of Engineers, U. S. Army, Washington, D. C. 20314

12. REPORT DATE: March 1978

13. NUMBER OF PAGES: 128

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): U. S. Army Engineer Waterways Experiment Station, Environmental Effects Laboratory, P. O. Box 631, Vicksburg, Mississippi 39180

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

TR-D-77-38-APP-C

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Assessments
Columbia River
Dredged material
Ecology
Field investigations
Miller Sands Island
Terrestrial habitats

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A study of existing conditions of terrestrial ecology at Miller Sands Island showed that the vegetation on the main island consists of open grassland areas and wooded areas. That the grassland contains scattered trees and shrubs indicates that succession from open grassland to wooded areas is occurring on the island.

Sixty-five different species of birds were observed. Changes in numbers

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20. ABSTRACT (Continued).

CONT

and species are attributed to the emigration of waterfowl and shorebirds. During spring and fall migrations the island and environs provide resting and habitat.

While birds have apparently colonized the island, mammals, amphibians, and reptiles have not. No amphibians or reptiles were observed during a search of suitable habitats. Since only a few small mammals were captured, numbers on the island are believed to be limited, with the exception of nutria. Nutria, which have relatively high water mobility, were observed during each sampling period and maintain trails in all habitat on the island.

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SUMMARY

INTRODUCTION

The Environmental Effects Laboratory of the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, is conducting a comprehensive research program to provide more definitive information on the environmental aspects of disposing of dredged material and to develop technically satisfactory, environmentally compatible, and economically feasible disposal alternatives. An important part of this program is the Habitat Development Project, which concerns the development of fisheries and wildlife habitat on a substrate of dredged material.

In connection with the Habitat Development Project, a disposal site in the Columbia River in Oregon has been chosen for study. Miller Sands Island is located approximately 24 miles upriver from the mouth of the Columbia River between mileposts 23 and 25. This location is approximately 10 miles northeast of Astoria, Oregon.

PURPOSE OF INVESTIGATION

The investigation is a study program designed to inventory and assess the terrestrial ecosystem of Miller Sands Island. Specifically, the study will enable evaluation of both short- and long-term changes in the plant and animal communities on Miller Sands Island and the surrounding wetlands resulting from deposition of dredged material and subsequent vegetative propagation. The investigation involves terrestrial and wetland biological field observations and sampling to provide baseline data for estimates of changes resulting from habitat improvement research.

SCOPE OF WORK

The investigation consisted of three major tasks: literature review, floral study, and faunal study. The flora and fauna were sampled during three field sampling periods occurring between 23 April 1975 and 24 June 1975. A fourth field trip was conducted on 8 August 1975 but was severely limited in scope (compared with the previous trips). Appendix A lists the plant species observed on Miller Sands.

The literature review was conducted in May and June 1975 in the libraries at Oregon State University, University of Oregon, and Portland State University. In addition, representatives of the U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Oregon Cooperative Wildlife Research Unit, Oregon State University Herbarium, and U.S. Army Corps of Engineers were contacted to obtain literature or biological information pertinent to Miller Sands Island. Lists of mammals (Appendix B, Table B1), birds (Table B2), and amphibians and reptiles (Table B3) that are expected to occur in suitable habitats along the lower Columbia River were compiled from distributions provided in the literature. Appendix C includes an annotated bibliography with relevant qualitative and quantitative information.

The floral study task involved qualitative and quantitative field sampling. Tree, shrub, and grassland communities were qualitatively studied during the second (21-26 May) and third (20-24 June) sampling periods, in order to delineate and determine their extent. Available NASA aerial color-infrared transparencies were used in conjunction with ground truth surveys. A map was prepared delineating the communities covering significant areas.

The grassland communities on the main island of Miller Sands were quantitatively sampled during the second and third sampling periods, using twenty 1-square-meter permanent quadrats. Species presence and percent cover were determined.

Wetland vegetation was sampled, utilizing two different methods. First, the communities were sampled during each of the first three sampling periods at 10 separate stations with 1-square-meter permanent quadrats to obtain species composition and percent cover. In addition, estimates of productivity and biomass accumulation of the dominant wetland species, using a modified Wiegert-Evans clip-plot technique (Wiegert and Evans 1964), were made during each of the four sampling periods.

During the third sampling period, the upper and lower vertical limits of distribution of the dominant wetland species were determined, as well as those ranges where optimum growth conditions appeared to be met.

Photographic documentation of the island was made from nine permanent camera points during each of the four field trips.

The field sampling of fauna was conducted in five broadly-defined habitat types, during the first three field trips only. To sample the small mammals, grids of 49 museum special snap traps placed at 10-meter intervals were established in each of five locations on Miller Sands Island during the May and June sampling periods. Five transects were established, one in each habitat type. Using these transects, avifauna were sampled using the sample-count method (Anderson 1970, 1972) during the first three sampling periods. Additionally, each of the transect lines established for avian censuses was traversed once during each sampling period to document presence and activity of medium-sized mammals. Evidence of activity (trails, tracks, burrows, dens, and diggings) was recorded.

Qualitative observations of fauna, including photographs, were recorded to document activity and occurrence of birds and mammals utilizing the island or adjacent waters.

DISCUSSION OF RESULTS

The literature review indicated that relatively little ecological information was available on the intertidal freshwater system of the

lower Columbia River. One item of interest to the present study is a description indicating that Lyngby's sedge *(Carex lyngbyei)* (a dominant species at Miller Sands) is replaced during succession by tufted hairgrass *(Deschampsia caespitosa)*. Additionally, both plants present potential sediment traps that could serve eventually to raise the level of a marsh surface. Additional information was found that described discrete vegetative hummocks as indicators of marsh development.

The literature review task enabled compilation of a list of mammals, birds, and reptiles expected to occur in appropriate habitats along the lower Columbia River. Additionally, waterfowl surveys and estimates of fur-bearing and game mammals were located and evaluated.

Additional quantitative information on aspects of flora and fauna of the lower Columbia River is being prepared by the Oregon Cooperative Wildlife Research Unit at Oregon State University.

The floral study showed that the vegetation on the main island consists of open grassland areas and wooded areas. The grassland community, which occupies the major portion of the island, is not uniform throughout in terms of species composition but consists of a mosaic of plant associations.

Field data supplemented by additional qualitative field observations indicate that plant cover can vary within this mosaic from essentially 0 percent to 100 percent.

The grassland also contains scattered young individuals and populations of several trees and shrubs, which indicate that succession from open grassland to wooded areas is occurring on the island.

The large wooded areas on the main island adjoining the south shore are dominated by Oregon alder *(Alnus rubra)* and black cottonwood *(Populus trichocarpa)*. Four of the largest living cottonwoods were cored, and their approximate ages were determined to be 36, 41, 38, and 36 years.

Although the vegetation of the sandspit areas is relatively sparse, compared to the grassland, a number of low-growing species are present.

The vertical distribution of the wetland plant communities ranges from approximately +1.4 feet mean lower low water (MLLW) to +7.4 feet MLLW, where it merges with the terrestrial communities.

Lyngby's sedge has the broadest range in terms of the elevational gradient. This may be partially a result of its successional attributes.

The field data demonstrate the rapid growth of the dominant species of the wetland vegetation between the April and June sampling periods.

Productivity estimates for wetland species were based on the Wiegert-Evans clip-plot method. However, since the number of wetland clip-plots utilized during this study was small (four) and the time limits of the study did not encompass an entire year, a strict application of the Wiegert-Evans method is not appropriate.

The four clip-plots represent biomass determinations for four different environmental situations and at least three communities or plant associations. A minimum productivity estimate based on these data for Clip-Plot 1 through the June sampling period is 1015 g/m^2, if peak standing crop of living material is considered. Similarly, for Clip-Plots 2, 3, and 4, the estimates are 208, 460, and 308 g/m^2, respectively. These estimates are within the lower range for estuaries and saltwater marshes.

Salix fluviatilis, Columbia River willow, is presently included on the Smithsonian Institution's list of "threatened" species in Washington and Oregon (Smithsonian Institution 1975). However the Conference on Rare and Endangered Plants in Oregon (March 1976, unpublished) removed the Columbia River willow from its list. During this conference, three species found on Miller Sands were added to Oregon's list, which are not on the Smithsonian list. These are *Salix drummondiana* (Drummond willow), *Amorpha canescens* (lead plant) and *Eryngium petiolatum* (coyote thistle).

During the April sampling period, no mammals were captured in 24 trap nights of sampling with snap traps; four Norway rats *(Rattus norvegicus)* were captured in 50 trap nights of sampling with Smith live traps. Rats were captured in habitats containing moist soil under dense stands of cottonwood and dogwood and near burrows in the grassland. Norway rats probably occur throughout the island in wooded habitat containing moist soil where woodlots, driftwood, stumps, or logs provide denning habitat.

During the second sampling period, 735 trap nights of effort with museum special snap traps yielded no captures in the sample grids. One Townsend's vole *(Microtus townsendii)* was taken from an isolated colony. During the third sampling period, three species of small mammals were captured. Five Townsend's voles, three Trowbridge's shrews *(Sorex trowbridgii)*, and one deer mouse *(Peromyscus maniculatus)* were captured in 735 trap nights of effort.

Because only nine small mammals were captured in 1470 trap nights of effort during the second and third sampling periods, numbers of small mammals on the island are believed to be limited.

Mammals observed during sampling periods included nutria and harbor seals. Surveys of active nutria trails on the main island and of fresh tracks in the marsh and on the sandspit indicated that nutria utilize all habitats on the island.

Avian censuses were conducted in each of five different habitat types between 6 a.m. and 11:00 a.m. during each of the sampling periods. Times that censuses were conducted varied as a response to weather conditions and to times that low tides occurred. Weather conditions were generally not optimal for avian activity. Wind, rain, or both wind and rain occurred during the times that censuses were being taken. Weather-induced inactivity of avifauna probably was responsible for reducing numbers of observations of certain birds.

Sixty-five different species of birds were observed on Miller Sands Island and adjacent waters and wetlands. Forty-eight, 32, and 33 different species were observed during the first, second, and third sampling periods, respectively. Changes in numbers and species of birds observed from April to June were attributed to the emigration of species of waterfowl and shorebirds observed in April and the immigration of additional passerine birds in May and June.

Between one and four bald eagles *(Haliaeetus leucocephalus)* were observed during each sampling period. Most of the birds were observed soaring over the island or adjacent waters. However, on two occasions, bald eagles were observed perched in snags on the east end of the island.

No amphibians or reptiles were observed during a search of suitable habitats.

No species of animals presently included on the list of threatened (USDI 1973) or endangered (USDI 1974) species were observed on or in the vicinity of Miller Sands Island.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are limited in scope since the study is a baseline data compilation rather than a study of cause and effect. Generally, they can be summarized in the following points:

Conclusions

- Based on qualitative observations and quantitative field data, the vegetative communities are undergoing succession from the grassland stage.
- The island and environs provide resting and habitat for waterfowl during spring and fall migrations.
- Mammals, amphibians, and reptiles have not colonized the island as birds apparently have. The exception is nutria, which have relatively high water mobility.

Recommendations

- Prior to upland habitat alteration, bird nesting surveys should be conducted.
- Prior to implementation of a nutria control program, we strongly recommend that studies be carried out to determine the following: (1) the reproductive status of nutria using the island, (2) the extent of the population utilizing the island, (3) the extent of movement of nutria between Miller Sands Island and nearby islands, and (4) the total impact of nutria on the vegetation of the island. Any chemical control programs for nutria should include consideration of the possibility of affecting the bald eagle population through secondary poisoning.
- Data collection for future wetland productivity studies should be continued through the entire year to improve on estimates presented in this study.
- The small isolated hummocks of vegetation in the cove should be examined in more detail to ascertain their elevation, successional status, and rate of expansion as indicators of natural marsh propagation.
- In planning the proposed experimental marsh, the plant species should be planted in the elevational range where they naturally appear as dominants or codominants in the existing vegetation.

PREFACE

The study of existing conditions (terrestrial ecology) at Miller Sands Island reported in the following document was performed by Woodward-Clyde Consultants under U.S. Government Contract #DACW57-75-C-0247 with the Portland District, U.S. Army Corps of Engineers, in cooperation with the Waterways Experiment Station (WES), Environmental Effects Laboratory, Vicksburg, Mississippi. The study was conducted from 23 April 1975 to 30 September 1975 as part of the Dredged Material Research Program.

The contracting officer for Portland District, Corps of Engineers was Major Richard H. Gates. Major Gates delegated technical responsibility to WES through Dr. Hanley K. Smith. The project manager for Woodward-Clyde Consultants was Alan D. Grant.

Authors of the report are Dr. C. David White, plant ecologist and principal investigator; Donald O. McKay, wildlife ecologist; and Alan D. Grant, environmental scientist. Field sampling on Miller Sands was conducted between 23 April and 8 August 1975.

Special recognition is given to Dr. John Byrne, who served as technical representative from WES; to David R. Parsons, also from WES, who was responsible in the initial stages for study design and coordination; and to Mr. Jerry Shelver, who made Corps of Engineers marine facilities near Astoria, Oregon, available at various times throughout the study.

Directors of WES during the conduct of this study and publication of this report were COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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FIGURES AND TABLES

CONVERSION FACTORS

U.S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To obtain
Miles	1.6093	Kilometers
Feet	0.308	Meters

INTRODUCTION

BACKGROUND

Through the Dredged Material Research Program, the Environmental Effects Laboratory of the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, is conducting a comprehensive research program to provide more definitive information on the environmental aspects of disposing of dredged material and to develop technically satisfactory, environmentally compatible, and economically feasible disposal alternatives. An important part of this program is the Habitat Development Project, which concerns the development of fisheries and wildlife habitat on substrates of dredged material. The project includes carefully planned and executed research studies on present dredging and disposal operations.

The objectives of the research project are to:

- determine what mechanisms cause the success or failure of attempted habitat development,
- determine the probable environmental impact of disposing of dredged material, and
- improve biological characteristics of the present site.

In connection with the Habitat Development Project, a disposal site in the Columbia River in Oregon has been chosen for study. Miller Sands Island is located approximately 24 miles upriver from the mouth of the Columbia River between mileposts 23 and 25. This location is approximately 10 miles northeast of Astoria, Oregon (Figure 1). The program of study for Miller Sands has been planned to proceed in four phases.

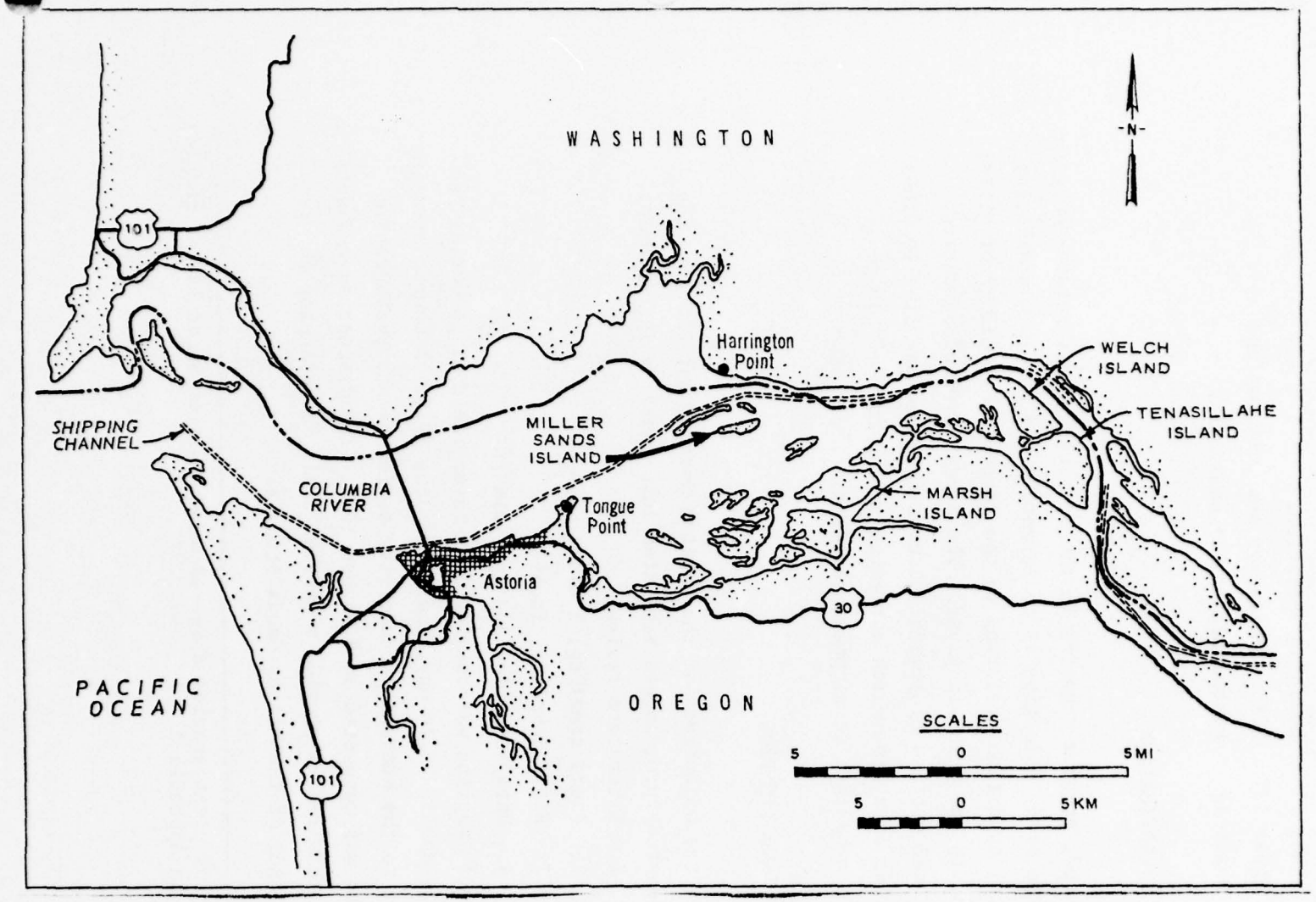

Figure 1. Vicinity map

Phase I	Inventory and assessment
Phase II	Dredging operations
Phase III	Site preparation and propagation
Phase IV	Postpropagational monitoring

PURPOSE OF INVESTIGATION

The study program reported in the following pages relates only to Phase I. The study objective is to inventory and assess the existing environmental conditions relating to the terrestrial ecology of Miller Sands Island in the Columbia River. The study involved conducting terrestrial and wetland biological observations and sampling to provide base-line data from which estimates can be made of changes resulting from habitat development research.

APPROACH OF INVESTIGATION

To meet the objectives of the Habitat Development Project, the Miller Sands study program was separated into tasks as listed below.

1. Literature review
2. Field sampling, flora*
3. Field sampling, fauna
4. Data reduction and analysis

The field sampling was completed in three field trips during the periods 23-29 April, 23-26 May, and 20-24 June 1975. A fourth sampling trip related to the wetland productivity estimates and photographic documentation was conducted on 8 August 1975. The discussion and data provided in this report provide a partial basis for planning the remaining three phases of the Miller Sands study site.

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* A listing of plant species observed on the Miller Sands Island complex is given in Appendix A.

DESCRIPTION OF INVESTIGATION

LITERATURE SEARCH

A review of literature applicable to research on Miller Sands Island was initiated 13 May 1975. The objective of the review was to obtain information pertaining to the following: (1) the biology of birds and mammals of Miller Sands Island, (2) the biology of fauna and freshwater intertidal habitats in the Pacific Northwest similar to those on Miller Sands Island, and (3) sandy dredged material deposits in other geographical areas.

The literature search was conducted in the libraries at Oregon State University, University of Oregon, and Portland State University. In addition, representatives of the U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Oregon Cooperative Wildlife Research Unit, Oregon State University Herbarium, and U.S. Army Corps of Engineers were contacted to obtain literature or biological information pertinent to Miller Sands Island.

Lists of mammals (Appendix B, Table B1), birds (Appendix B, Table B2), and amphibians and reptiles (Appendix B, Table B3) that are expected to occur in suitable habitats along the lower Columbia River were compiled from distributions provided in the literature (Hall and Kelson 1959; Ingles 1965; Verts 1971; Alcorn 1971; Bertrand and Scott 1971; Gabrielson and Jewett 1970; Masson and Mace 1965; and Slater 1963*b*, 1964*b*).

FLORA

General Description

Miller Sands Island and the major portion of the associated wetlands have been formed from dredged material removed from the Columbia River Shipping Channel between the 1930s and the present. The recently deposited dredged material appears as a rather barren sandy spit extending from the main island to complete a horseshoe-shaped island complex, Figure 2. Although these sandy areas have little vegetative cover, several plant species are present. The shores of the island and wetlands are under freshwater tidal influence, with daily fluctuations approaching a maximum of 11 feet. The presence of the freshwater tidal fluctuations is directly related to a wedge of salt water that enters the mouth of the Columbia River and estuary during tidal cycles and is overlain by the fresh water draining from the river system.

Several plant communities are represented on Miller Sands Island. In the intertidal range are found three aquatic marsh communities, with common spike-rush *(Eleocharis palustris)*,* Lyngby's sedge *(Carex lyngbyei)*, and tufted hairgrass *(Deschampsia cespitosa)* occurring as the dominant species. At the upper limit of the tidal fluctuations is a thicket of various willows *(Salix* spp.*)*; above this are found groves of Oregon alder *(Alnus rubra)* and black cottonwood *(Populus trichocarpa)*. Most of the main island does not have a tree overstory and can best be described as a grassland with occasional Oregon alder, black cottonwood, willows, Douglas fir *(Pseudotsuga menziesii)*, Sitka spruce *(Picea sitchensis)*, and western hemlock *(Tsuga heterophylla)*. Numerous herbaceous species are found within this open area.

Sampling Methods

The Oregon alder, black cottonwood, and willow communities were sampled during the second (23-26 May) and third (20-24 June) sampling periods, with the objective being to delineate and determine the extent

*Plant nomenclature follows Hitchcock and Cronquist (1973).

of the associated communities. Available NASA aerial color-infrared transparencies were used in conjunction with ground truth surveys. The ground truth surveys included determination of species present, qualitative estimates of species dominance within each community, and descriptions of its stratified components (canopy, understory, shrub, and herbaceous) where appropriate.

The herbaceous communities in the grassland on the main island of Miller Sands were sampled during the second (23-26 May) and third (20-24 June) sampling periods using twenty 1-square-meter permanent quadrats (Figure 2). Species presence and percent cover were determined. The twenty quadrats were located subjectively to ensure adequate sampling of the herbaceous vegetation of the open areas of the main island and were not located in communities having a shrub or woodland overstory. Emphasis was placed on the eastern half of the main island in anticipation of potential upland habitat manipulations of that area in the future.

Estimates of percent cover of the species present in each of the permanent quadrats on the main island were made with consideration of the amount of bare ground surface exposed. The scale of percent cover was similar to that of Phillips (1959) but estimated to the nearest percent from zero to ten percent cover and then to the nearest five percent from ten to 100 percent. Bare ground surface was estimated and listed in subsequent data reductions in a separate category; hence the total species coverage and bare ground did not exceed approximately 100 percent of the total quadrat area. Lichens and mosses present in these quadrats were not identified to species.

Relative dominance, relative frequency, and importance values were calculated from data obtained from these terrestrial quadrats utilizing formulas similar to those described by Phillips (1959, p. 43). The formulas are as follows:

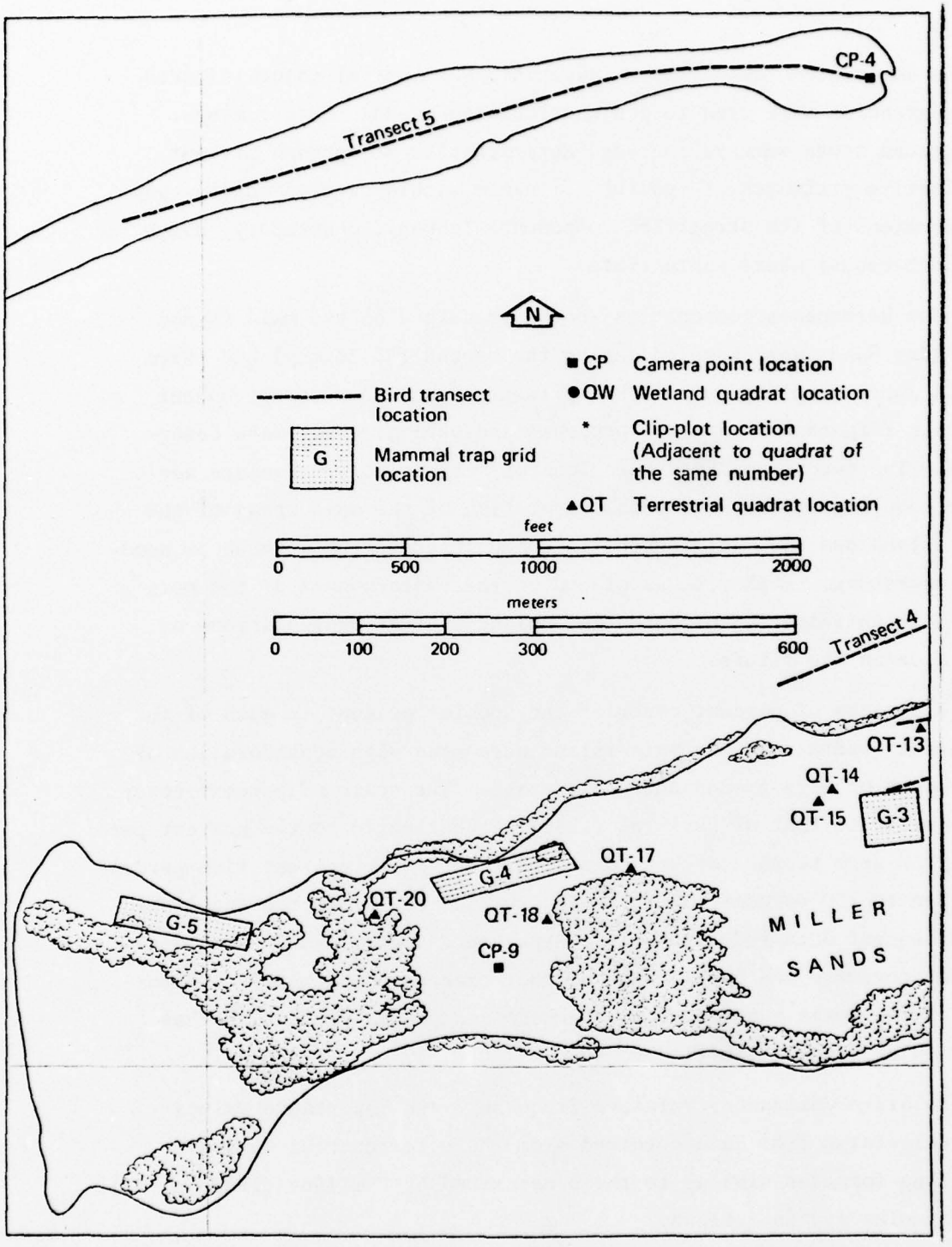

Figure 2. Location of sampling quadrats, clip-plots, and camera points on the Miller Sands Island Complex

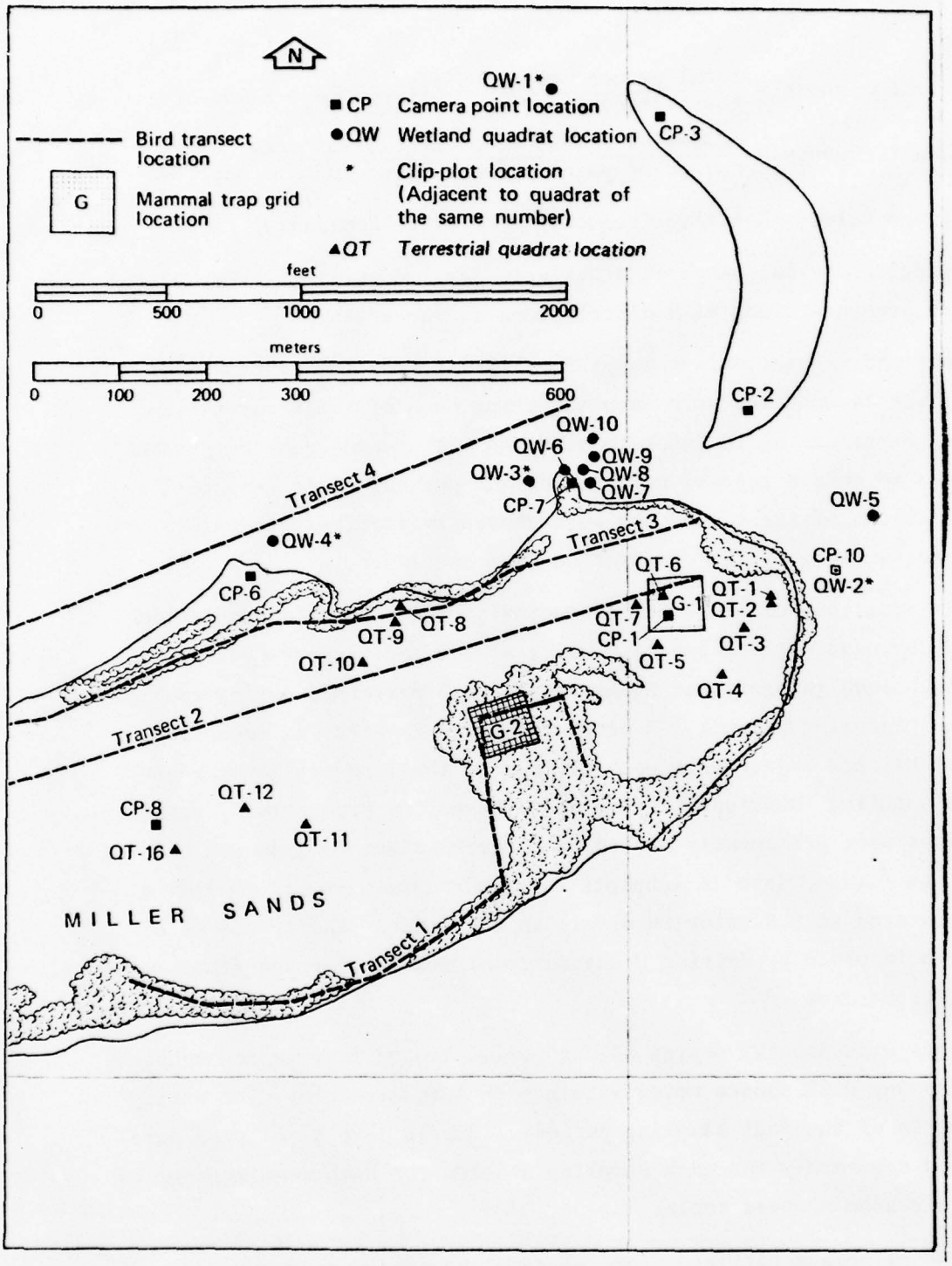

Figure 2 (Continued)

$$\text{Relative Dominance} = \frac{\text{total percent cover of species i}}{\text{total percent cover of all species}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{number of points of occurrence of species i}}{\text{number of points of occurrence of all species}} \times 100$$

Importance Value = Relative Frequency + Relative Dominance

The dredged material sandspit areas were sampled qualitatively, noting species presence along with descriptions of the areas.

Wetland vegetation was sampled utilizing two different methods. First, the communities were sampled during each of the first three samplings periods at 10 separate stations with 1-square-meter permanent quadrats to obtain species composition and percent cover (Figure 2). The locations of these quadrats were chosen subjectively to ensure adequate sampling of the dominant wetland species.

In addition, estimates of productivity and biomass accumulation of the dominant wetland species, using a modified Wiegert-Evans clip-plot technique (Wiegert and Evans 1964), were performed during each of the four sampling periods. A permanent plot, 2 meters on each side, was established adjacent to each of four of the 1-square-meter vegetative sampling locations (Figure 2). These four productivity sampling locations were permanently marked with square aluminum frames. Each frame was divided into 16 subplots using aluminum wire strung through holes located at 0.5-meter intervals in the frame. The frames were anchored in place by driving U-shaped metal stakes over the frame along its borders.

This experimental design allowed selection of four random subplots encompassing 0.25 square meter within each 4-square-meter plot during the course of the four sampling periods. Subplots to be clipped were selected separately for each sampling station for each sampling period using a random-numbers table.

The clippings obtained from the sampling procedures were identified as to sample location, subplot clipped, and date of clipping. The treatment of these clipped samples generally followed the Wiegert-Evans

clip-plot technique of sorting by species, and separation of green and dead plant material. The samples were then dried in a Soiltest Model L-5 drying oven at 60°C to a constant weight and weighed on a Metler Model H-10-T balance.

The subplots that were clipped during the first and second sampling periods were reclipped during the third sampling period to ascertain the amount of growth that occurred during the previous four and eight weeks on those subplots. During the fourth sampling period, those subplots that were initially clipped during the third sampling period were also reclipped.

During the third sampling period, the upper and lower vertical limits of distribution of the dominant wetland species were determined, as were those ranges where optimum growth conditions appeared to be met. The selection of sample points was neither objective nor random but completely subjective; i.e., stratified to meet the objectives of this portion of the study, with upper limits, lower limits, and luxuriant stands of particular species being the main criteria for sample point selection. Height above mean lower low water (MLLW) for each of approximately 200 sample locations was determined in the field in conjunction with a U.S. Army Corps of Engineers survey team.

Sampling Periods and Locations

The three sampling periods were 23-29 April, 23-26 May, and 20-24 June 1975. The fourth sampling period on 8 August 1975 was devoted to wetland productivity estimates and photographic documentation only. All permanent quadrats in both the wetland and terrestrial areas were located and identified on a reference map of Miller Sands Island by a U.S. Army Corps of Engineers survey team. The reference map is reproduced in Figure 2.

Number and Location of Camera Points for Photographic Documentation

Nine permanent camera points were established during the first sampling period (Figure 2). These points were selected to illustrate and record the major terrestrial and wetland communities and to emphasize the eastern end of the Miller Sands Island complex and those areas under current investigation for potential habitat improvement. A series of color photographs was taken during each sampling period at each camera point. The camera points were located and identified on the reference map by the Army survey team.

Voucher Specimens

Plant specimens collected during the first three sampling periods were pressed, dried, and identified using Hitchcock and Cronquist (1973) as to species, date, and location. Voucher specimens were prepared for submittal to the Waterways Experiment Station, with duplicates retained for future reference in the Woodward-Clyde herbarium. These specimens included those encountered at sample locations and those observed during reconnaissance and travel between permanent sample locations within the study area.

FAUNA

Description of Habitats

Five habitat types were defined to facilitate sampling of fauna. These habitat types are briefly described as follows:

1. South shore (Transect 1, Figure 2). This habitat consists of an irregular broad band of vegetation dominated by large black cottonwood and Oregon alder in the overstory. Understory species included Oregon ash *(Fraxinus latifolia)*, Pacific ninebark *(Physocarpus capitatus)*, common snowberry *(Symphoricarpos albus)*, willow *(Salix* spp.*)*, and salmonberry *(Rubus spectabilis)*.

2. Grassland (Transect 2, Figure 2). This habitat is located in the center portion of the island. Vegetative dominants include common scouring-rush *(Equisetum hyemale)* and common velvetgrass *(Holcus lanatus)*, with heavy lichen and moss cover and scattered willows and black cottonwoods.

3. North shore (Transect 3, Figure 2). This habitat consists of narrow bands of willow and alder, with occasional red-osier dogwood *(Cornus stolonifera)* creating an ecotonal type. Although many of the plant species are similar to those of the south shore habitat, the north shore habitat is less extensive and successionally younger than the south shore.

4. Intertidal marsh (Transect 4, Figure 2). This habitat consists of a freshwater marsh, dominated by Lyngby's sedge *(Carex lyngbyei)* and common spike-rush *(Eleocharis palustris)*, and mud flats that are inundated at high tide.

5. Sandspit (Transect 5, Figure 2). This habitat consists of a barren sandspit recently created by deposition of dredged material (sand). The sandspit has little vegetative cover and is located adjacent to the shipping channel (Figure 1) on the Columbia River. An extensive sand flat on the south side of the spit is exposed at low tide.

Sampling Methodology for Mammals

The north shore, grassland, and south shore habitat types were sampled for mammals on 23-29 April, 23-26 May, and 20-24 June 1975. No mammal trapping was conducted in the intertidal marsh or the sandspit. During the first sampling period, 12 snap traps and 25 Smith live traps were placed in the different habitat types on the island to determine the species of mammals present and the most suitable locations for placing trap grids during subsequent sampling periods. Traps were set and checked for two consecutive days.

Based on the findings of the April sampling, grids of 49 Museum Special snap traps, placed at 10-meter intervals, were established in each of five locations on Miller Sands Island during the May and June sampling periods. The locations of the five grids are shown in Figure 2. Grid 1 was placed in a portion of the grassland on the eastern side of the island. Grid 2 was placed in the south shore community. Grid 3 was located in the grassland near the center of the island in a scouring-rush, moss, velvetgrass habitat type. Grid 4 was placed in a young cottonwood, willow, scouring-rush habitat on the north shore. Grid 5 was placed in a north shore habitat type dominated by rush, Scot's broom *(Cytisus scoparius)*, willow, and driftwood.

Sampling Methodology for Birds

Avifauna were sampled using the sample-count method (Anderson 1970, 1972) during each sample period. Five 900-meter transects were established in the following habitat types: Transect 1 was established on the south shore; Transect 2 was established in the grassland; Transect 3 was located on the north shore; Transect 4 was placed in the intertidal marsh; Transect 5 was placed on the sandspit. Ten sample stations were located at 100-meter intervals on each of the transects. Transect lines on the main island (Transects 1 through 3) were traversed between daylight and 9:00 a.m. once during each of the sampling periods. Observations were made from each sample station for 10 minutes. The observer moved slowly between sample stations to minimize disturbance. All species of birds observed within 20 meters of sample stations or transect lines were recorded. Transects placed in the intertidal marsh (Transect 4) and the sandspit (Transect 5) were traversed during the low tide to include in the census those birds utilizing the exposed mud flats. All species of birds observed within 100 meters of the sample stations and transect lines of Transects 4 and 5 were recorded.

Bird species diversity was calculated using Shannon and Weaver's (1949) formula:

$$H = -\sum_{i=1}^{s} p_i \log_e p_i$$

Where H = species diversity index

s = number of species

p = proportion of the total number of individuals that belong to species i

Each of the transect lines established for avian censuses was walked once during each sample period to document presence and activity of medium-sized mammals. Evidence of activity (including trails, tracks, burrows, dens, and diggings) was recorded.

Qualitative observations of fauna, including photographs, were recorded to document activity and occurrence of birds and mammals utilizing the island or adjacent waters.

DISCUSSION OF RESULTS

LITERATURE REVIEW

Relatively little ecological information was found to be available on the intertidal freshwater system of the lower Columbia River. The recent thesis of Jefferson (1974) describes the vegetation and successional status of many Oregon coastal salt marshes and briefly comments on coastal freshwater marshes. Some of the plant species discussed in relation to saltwater marshes also occur in the wetlands of Miller Sands Island. Johannessen (1964) describes the expansion of a coastal salt marsh, and again a few of the species noted occur at Miller Sands.

A description of the Pacific Coast beach strand vegetation and its floristic groupings is presented by Breckon and Barbour (1974), along with autecological information of some characteristic species. Many of the species found on the coastal strand are also found on Miller Sands Island and associated wetlands.

Plant succession on Oregon sand dunes, which is similar in many respects to succession on Miller Sands, is described by Kumler (1969). Succession within Oregon salt marshes is described by Jefferson (1974). DeSelm and Shanks (1967) describe successional trends in a freshwater marsh situation. Both of these latter studies indicate the successional role of various *Carex* species. Important to the present study, Jefferson's findings indicate that Lyngby's sedge *(Carex lyngbyei)* is replaced by tufted hairgrass *(Deschampsia cespitosa)*. Additionally, both species trap sediments and thereby raise the level of the marsh surface.

Sediment deposition or accretion in salt marshes has been estimated by Jefferson (1974) and Redfield (1972). Redfield provided additional information on marsh development and rate of expansion of vegetation occurring as isolated hummocks.

A comprehensive study of the Missouri River wetlands by Weaver (1960) provides information on species of sedges, rushes, and bulrushes (*Juncus, Eleocharis, Scirpus,* and *Carex),* which are ecologically similar to those found at Miller Sands.

The basic method used to estimate productivity is described by Wiegert and Evans (1964) in their study of grassland productivity. A modification and simplification of this method is provided by Lomnicki et al. (1968). Kelly et al. (1974) compared various methods of estimating net primary production and recommended sampling intervals for the different methods based on their comparative results. Keefe (1972) provided a review of the literature on marsh productivity studies sampled by various methods and tabulated the estimates obtained for individual species.

Relatively little ecological information was found to be available on the fauna of the lower Columbia River. Memoranda* concerning surveys of lower Columbia River islands for inclusion into the National Wildlife Refuge System provide some information on the fauna occupying what are now the Columbian White-Tailed Deer and the Lewis and Clark National Wildlife Refuges. In September 1969, Marshall observed mallards *(Anas platyrhynchos)*, herons, and grebes on or near the islands. In June 1970, while visiting Tenasillahe Island (Figure 1), Marshall observed Columbian white-tailed deer *(Odocoileus virginianus leucura),* mallards, wood duck *(Aix sponsa)* broods, "hundreds of band-tailed pigeons"

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*Memoranda and reconnaissance reports dated 6 October 1969, 18 June 1970, and 9 July 1970, by David B. Marshall, Regional Refuge Biologist of the U.S. Fish and Wildlife Service in Portland, concerning observations of wildlife and habitats in the proposed Columbian White-Tailed Deer National Wildlife Refuge and the Lewis and Clark National Wildlife Refuge.

(Columba fasciata), and a number of songbirds. He reported that raccoons *(Procyon lotor)* were abundant on Tenasillahe Island.

Lower Columbia River islands are wintering, resting, and feeding habitats for Pacific Flyway waterfowl originating in Alaska (Personal Communication, D. B. Marshall, 9 July 1970). Largest concentrations of waterfowl utilize the islands in the spring; followed by winter, fall, and summer use in order of importance.

According to Marshall, the islands in the lower Columbia River (now included in Lewis and Clark National Wildlife Refuge) typically support 3000 whistling swans *(Olor columbianus)*, 2000 dusky Canada geese *(Branta canadensis occidentalis)*, and 50,000 ducks in February and March. Surveys taken in December and January indicated the presence of about 1000 whistling swans, 2000 dusky Canada geese, and 10,000 ducks.

Surveys of waterfowl (ducks and geese) taken in the fall (Oregon Cooperative Wildlife Research Unit 1974) recorded the following numbers of birds using the lower Columbia River: 4340 in September, 6398 in October, and 9742 in November. Band-tailed pigeons also frequent islands that provide brushy habitat (Marshall 9 July 1970). Some mallards, cinnamon teal *(Anas cyanoptera)*, blue-winged teal *(Anas discors)*, wood ducks, and Great Basin Canada geese *(Branta canadensis moffitti)* nest along the lower Columbia (U. S. Army Engineer District, Portland 1974). In addition, mergansers, American coots *(Fulica americana)*, and grebes nest on the river (Claire et al. 1971).

Estimates of numbers of fur-bearing and game mammals that occur in the lower Columbia River floodplain from the Columbia County line to Astoria (Claire et al. 1971) are: 2000 beaver *(Castor canadensis)*, 5000 muskrat *(Ondatra zibethica)*, 1500 mink *(Mustela vison)*, 150 river otter *(Lutra canadensis)*, 400 black-tailed deer *(Odocoileus hemionus columbianus)*, and 250 white-tailed deer. Although no estimates of numbers of nutria *(Myocastor coypus)* utilizing the low Columbia were obtained, some estimates of numbers of animals taken for furs were available. Dave Fisher (personal communication 1975), Manager of the Lewis and Clark National Wildlife Refuge, indicated that during the 1974-75 trapping season approximately

2500 to 3000 nutria were removed from the refuge. These data were obtained from refuge trappers, duck hunters, fur buyers, and others.

Harbor seals *(Phoca vitulina)* and northern sea lions *(Eumetopias jubata)* are reported occasionally in the Columbia River. Pearson and Verts (1970) reported 77 seals on 2 March 1968. An unidentified source reported 78 seals hauled out near Miller Sands Island in February 1975 and 12 seals hauled out near the island in June 1975.

The Columbian white-tailed deer occurs in limited numbers in the lower Columbia region. This mammal has been classified as endangered by the U.S. Fish and Wildlife Service (USDI 1974). Between 250 and 300 deer are believed to be distributed along the Columbia in Oregon and Washington (USDI 1973). Marshall (9 July 1970) reported Columbia whitetails on Tenashillahe and Welch islands (Figure 1). Suring (1975) provided quantitative information concerning activity, behavior, aspects of life history, and descriptions of the habitat of the Columbian white-tailed deer.

Other published information available on the vertebrates of the lower Columbia River concerns the potential impacts of water fluctuation on wildlife and recreational resources (Claire et al. 1971), the nesting status of Canada geese (Yocom 1961), the effects of the Columbia River on distribution of amphibians and reptiles (Storm 1966) and of mammals (Gordon 1966), and the distribution and abundance of harbor seals and sea lions (Pearson and Verts 1970).

Taxonomic publications provide information on occurrence of mammals (Ingles 1965, Verts 1971), birds (Gabrielson and Jewett 1970, Masson and Mace 1965, Alcorn 1971, Bertrand and Scott 1971), and amphibians and reptiles (Slater 1963*a*, 1963*b*, 1964*a*, 1964*b*; Anderson and Slater 1941) in Oregon and Washington that can be applied to the lower Columbia River region.

Publications on nutria (Peloquin 1969, Kuhn and Peloquin 1974, Evans 1970), western sandpipers *(Calidris mauri)* (Holmes 1972),

waterfowl (Dwyer 1970), and microtines (Goertz 1964) supply information on the biology of other vertebrates utilizing Miller Sands Island.

Information on the relationships of birds to vegetative associations (Anderson 1970, 1972; Kricher 1972, 1973; Shugart and James 1973; Tramer 1969) is particularly applicable to the biological studies on Miller Sands Island. Two papers concerning the effects of water fluctuation on small mammals (Shure 1971, Donohoe 1966) were located.

Articles by Chamberlain (1959) and by Keith and Stanislawski (1960) provide data on the utilization of marsh vegetation as food for various waterfowl species.

The annotated bibliography (Appendix C) contains more detailed descriptions (including quantitative data) of the references mentioned above.

FLORA

Terrestrial Communities

Data on percent cover is presented in Tables 1 and 2.

Grassland. The grassland community, which occupies the major portion of the island, is not uniform throughout in terms of species composition but consists of a mosaic of plant associations (Figure 3). Within this mosaic, the percentage of plant cover can vary from essentially 0 percent to 100 percent. At any particular location, mosses, lichens, grasses, or forbs may be present as the dominant vegetative group. During April the common scouring-rush *(Equisetum hyemale)* is visually quite evident. Later, common velvetgrass *(Holcus lanatus)* and other grasses, stream lupine *(Lupinus rivularis)*, least hop clover *(Trifolium dubium)*, hairy cats-ear *(Hypochaeris radicata)*, and English plantain *(Plantago lanceolata)* are commonly encountered and contribute strongly to the visual composition of the grassland.

Table 1

Percent Cover of Plant Species Present in Terrestrial Quadrats
During May Sampling Period (23-26 May 1975)

Species	Percent Cover by Quadrat Number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equisetum hyemale	1	2	10	5	1	2	2	3	5	3		10	2	tr	tr		1	1	5	5
Holcus lanatus	2	tr	2	45	90	2		2	50		2	tr	3	1	2	tr	1	2	5	5
Hypochaeris radicata	1	tr	tr	tr	2	1	3	2	2		3	2	2			5	tr	tr	3	
Aira caryophyllea	tr		tr		1	30	2	30	2	1	2	35	40	2	10	70	55	2		
Aira praecox	tr				5					tr										
Cerastium nutans			tr	tr					1				tr	tr	1		1		10	tr
Anaphalis margaritacea			15						tr											
Hypericum perforatum				1	3															
Lupinus rivularis				1	3	2		tr	7		10	5	5	1	15	5	tr			
Festuca myuros						5	2													
Rumex acetosella								1	1			tr	tr	1			1	tr		
Pteridium aquilinum								10												
Arabidopsis thaliana								tr	1											
Poa nemoralis									5								35		50	
Antennaria sp.										tr										
Plantago lanceolata												5			3	1		3	15	

(Continued)

Note: Location of quadrats is given in Figure 2.
tr indicates trace, i.e. less than 1 percent.

Table 1 (concluded)

Species	Percent Cover by Quadrat Number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Trifolium dubium												35					2		1	
Lathyrus japonicus													5							45
Festuca arundinacea															25					3
Vicia cracca															3		1		5	
Crepis nicaeensis																tr				
Myosotis discolor																			tr	
Lichens	1	90	70				47†		7			3					2			
Mosses	95	5	70	45		55	45	47	15	5	80	3	35	75	40	10	1	90	2	40
Bare ground								1		90	1	5	7	20		10				

†Overlaid with dead stems of *Equisetum hyemale*

Table 2

Percent Cover of Plant Species Present in Terrestrial Quadrats
During June Sampling Period (20-24 June 1975)

Species	Percent Cover by Quadrat Number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Equisetum hyemale	2	1	10	10	10	3	15	5	15	3		15	tr	tr	1		5	1		5
Holcus lanatus	3	tr	2	5	70	2		5	50		2	tr	5	1	15	tr	tr	3		2
Hypochaeris radicata	tr	tr	tr	tr	2	1	3	2	1		2	2	3			1	1	tr		
Aira caryophyllea	1		2		5	3	2	3		tr		5	5	2	2	25	10	1		
Aira praecox	1				tr					tr										
Poa nemoralis		tr					tr	2	1		1		3			5	75			
Cerastium nutans			1	tr	tr				tr					tr	1		1			
Anaphalis margaritacea			15						tr											
Hypericum perforatum				2	1															
Lupinus rivularis				1	10	15	tr	3	10		15	15	10	1	20	5	2			
Crepis nicaeensis				tr	tr		1				3					2				
Festuca myuros						20	5													
Rumex acetosella								tr	tr			1	tr	1	tr		tr	tr		
Pteridium aquilinum								30												
Antennaria sp.										tr										
Plantago lanceolata												1			2	1		4		

(Continued)

Note: Location of quadrats is given in Figure 2.
tr indicates trace, i.e. less than 1 percent.

Table 2 (concluded)

Species	Percent Cover by Quadrat Number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Trifolium dubium												55				tr	1			
Lathyrus japonicus													7							80
Festuca arundinacea															20					1
Vicia cracca															tr					
Trifolium pratense																				1
Lichens	1	90					45†		5			1								
Mosses	90	7	70	80		55	25	45	20	5	75		65	75	40	45		90		10
Bare ground		tr						2		90	2	2	2	20		15	5			

†Overlaid with dead stems of *Equisetum hyemale*

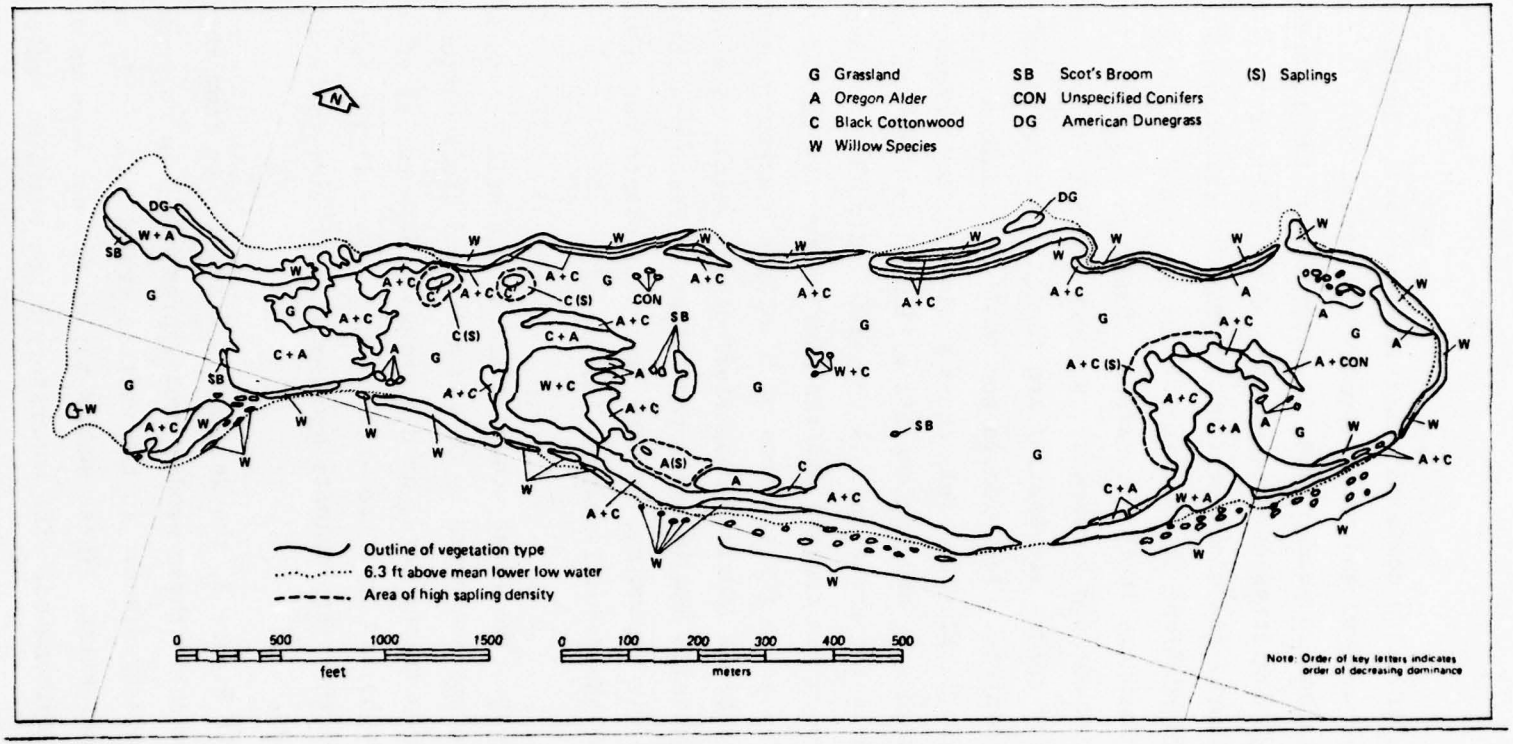

Figure 3. Plan map showing distribution of major vegetative communities

The grassland also contains scattered young individuals and populations of several tree and shrub species indicating that succession from open grassland to wooded areas is occurring on the island. Typical areas with high densities of saplings are shown in Figure 3. Oregon alder *(Alnus rubra)* and black cottonwood *(Populus trichocarpa)* saplings are commonly found along the margins of the woods and thickets, and occasionally elsewhere in the grassland. Saplings and young trees of Douglas fir *(Pseudotsuga menziesii)*, western hemlock *(Tsuga heterophylla)*, and Sitka spruce *(Picea sitchensis)* are found as scattered individuals within the open areas. Individuals and small populations of Columbia River willow *(Salix fluviatilis)*, coast willow *(S. hookeriana)*, Pacific willow *(S. lasiandra)*, and Mackenzie's willow *(S. rigida* var. *mackenzieana)* are also found in the grassland. A very few individuals of evergreen huckleberry *(Vaccinium ovatum)* and red huckleberry *(V. parvifolium)* are also present, as are a few clusters of Himalayan blackberry *(Rubus discolor)*. Scot's broom *(Cytisus scoparius)* occurs mainly as a very few scattered individuals and in small populations. These populations do not seem to be rapidly expanding, as very few young plants were observed in the vicinity of the sexually mature individuals.

Wooded areas. The large wooded areas on the main island adjoining the south shore are dominated by Oregon alder and black cottonwood. The oldest vegetation exists here, as determined from a series of early aerial photographs and from tree-ring counts. Four living cottonwoods were cored, and their approximate ages were determined to be 36, 41, 38, and 36 years.

As shown in Figure 3, the dominant species differ from region to region within each of these wooded areas, presumably in response to the existing moisture gradient. In the wettest areas, relatively small swamps or marshes exist. These swamps may or may not have an overstory of black cottonwood. The understory often contains red-osier

dogwood *(Cornus stolonifera)* and willows *(Salix* spp.*)*. Herbaceous species present are lady-fern *(Athyrium filix-femina)*, dense sedge *(Carex densa)*, meadow buttercup *(Ranunculus acris)*, false hellebore *(Veratrum californicum)*, Pacific bedstraw *(Galium cymosum)*, and an occasional cow-parsnip *(Heracleum lanatum)*.

The dominant canopy species in the wooded areas outside the swampy regions is black cottonwood or Oregon alder or both. Commonly, the two trees are found as codominants (Figure 3), with black cottonwood being numerically more frequent than Oregon alder in the more mesic situations, while the reverse occurs on the more xeric sites.

Minor components of the canopy are Oregon ash *(Fraxinus latifolia)*, big-leaf maple *(Acer macrophyllum)*, Sitka spruce, western hemlock, and a very few individuals of western red cedar *(Thuja plicata)*. These species are also found as saplings in the understory.

The major components of the understory are various willow and red-osier dogwood (especially in the more moist regions) as well as Pacific ninebark *(Physocarpus capitatus)* and red elderberry *(Sambucus racemosa)*. Common snowberry *(Symphoricarpos albus)* occurs frequently in the drier areas and along the margins of the woods, and thimbleberry *(Rubus parviflorus)* is encountered in areas with more open canopies. Salmonberry *(Rubus spectabilis)* and Himalayan blackberry are found in the woods, but they appear more frequently, with a few individuals of Nootka rose *(Rosa nutkana)*, along the wood-grassland margins. Indian plum *(Osmaronia cerasiformis)* occurs as scattered individuals in the understory, being most frequently found in the more xeric habitats in the woods.

The herbaceous component of these wooded areas is rather depauperate in terms of the number of species present and percent cover. Both common horsetail *(Equisetum arvense)* and common scouring-rush occur, as well as a few individuals of cow-parsnip and false hellebore.

Rattlesnake plantain *(Goodyera oblongifolia)* occurs infrequently, as do English plantain and Pacific bedstraw. The evergreen blackberry *(Rubus laciniatus)* occurs sporadically but is locally abundant, especially in the more open areas along the margins of the woods.

In other areas along the south, east, and north shores, thickets exist where the dominants are various species of willow. On somewhat higher ground, Oregon alder and black cottonwood become increasingly more frequent than the various willows and represent the codominant and dominant species in the canopy (Figure 3). These areas support younger stands of trees and tend to have more open canopies than the previously described wooded areas.

In the willow thickets the understory is mainly herbaceous, comprised of tufted hairgrass *(Deschampsia cespitosa)*, Pacific silverweed *(Potentilla pacifica)*, some tall fescue *(Festuca arundinacea)*, along with varying amounts of European beachgrass *(Ammophila arenaria)*, rushes *(Juncus* spp.*)*, birds-foot trefoil *(Lotus corniculatus)*, and common scouring-rush.

The zone of Oregon alder and black cottonwood above the willows has a few individuals of big-leaf maple, Oregon ash, and sweet cherry *(Prunus avium)* in the canopy. The shrub understory contains considerable numbers of common snowberry, red elderberry, salmonberry, red-osier dogwood and some individuals of Himalayan blackberry and Pacific ninebark. Occasional individuals of bristly manzanita *(Arctostaphylos columbiana)* and black hawthorn *(Crataegus douglasii)* are also found. Black twinberry *(Lonicera involucrata)* and giant vetch *(Vicia gigantea)* are also encountered frequently.

Between the alder and cottonwood thickets, in gaps in the willow thickets, and along their respective margins are open-canopied areas that support a rather diverse flora. Some of these areas are similar to northwestern coastal sand dunes, with stands of American dunegrass

(Elymus mollis) present, along with beach pea *(Lathyrus japonicus)* and European beachgrass. Other areas, which have a high concentration of logs and other driftwood debris, support scattered individuals of Oregon ash, Oregon alder, and black cottonwood, along with occasional red huckleberry, bearberry *(Arctostaphylos uva-ursi)*, fireweed *(Epilobium angustifolium)*, beach pea, common velvetgrass, and bittersweet nightshade *(Solanum dulcamara)*.

The remaining open-canopied areas between the thickets support the following frequently encountered species in varying abundance: black twinberry, giant vetch, tufted hairgrass, English plantain, beach pea, Scot's broom, red clover *(Trifolium pratense)*, white clover *(Trifolium repens)*, cow-parsnip, foxglove *(Digitalis purpurea)*, forget-me-not *(Myosotis discolor)*, pearly everlasting *(Anaphalis margaritacea)*, common St. John's-wort *(Hypericum perforatum)*, and common scouring-rush.

Although the vegetation of the sandspit areas is sparse, a number of species are present on these areas. Barley *(Hordeum vulgare)* had apparently been planted in the fall of 1974 in a small experimental area of the sandspit by an anonymous individual or group. The most frequently encountered naturally established species is American searocket *(Cakile edentula)*, a hummock-forming species commonly found on coastal sand dunes. Several grasses occur as scattered clumps; among them are the introduced European beachgrass, tufted hairgrass, tall fescue, and reed canarygrass *(Phalaris arundinacea)*. Two legumes, beach pea and white clover, are found only occasionally, as are bittersweet nightshade and English plantain. The only trees or shrubs noted were small saplings of willows and black cottonwood.

Terrestrial Quadrat Information

Tables 1 and 2 indicate the species present and their percent cover for the terrestrial quadrats during the May and June sampling periods,

respectively. Quadrat 19 was destroyed by unknown persons sometime between the two sampling periods (May 23-26 and June 20-24).

Mosses accounted for a large portion of the vegetative cover during both sampling periods while percent cover of other species increased or decreased during the same interval, depending on the stage of phenological development of the species.

The respective contribution of each plant species to the overall floristic composition of the grassland can be determined from the importance values presented in Tables 3 and 4. In determining the relative dominance values given in these tables, percent cover values listed in Tables 1 and 2 as "tr" (less than 1 percent cover), were assigned an arbitrary value of 0.5 to facilitate the calculations. For convenience, the order of the species listed in Tables 3 and 4 follows the ordering in the preceding percent cover tables (Tables 1 and 2).

During the May sampling period (Table 3), the first eight species in order of decreasing importance value were these: various mosses, silver hairgrass *(Aira caryophyllea)*, common velvetgrass *(Holcus lanatus)*, common scouring-rush *(Equisetum hyemale)*, hairy cats-ear *(Hypochaeris radicata)*, various lichens, stream lupine *(Lupinus rivularis)*, and woods bluegrass *(Poa nemoralis)*.

During the June sampling period (Table 4), the importance values changed with this resulting order of decreasing values: various mosses, common velvetgrass, common scouring-rush, stream lupine, silver hairgrass, various lichens, hairy cats-ear, and woods bluegrass.

Table 3

Relative Frequency, Relative Dominance, and Importance Values of Plant Species Present in Terrestrial Quadrats During May Sampling Period (23-26 May 1975)

Species	Relative Frequency	Relative Dominance	Importance Value
Equisetum hyemale	11.76	3.19	14.95
Holcus lanatus	11.76	11.61	23.37
Hypochaeris radicata	10.46	1.54	12.00
Aira caryophyllea	10.46	15.24	25.70
Aira praecox	1.96	0.32	2.28
Cerastium nutans	5.88	0.83	6.71
Anaphalis margaritacea	1.31	0.83	2.14
Hypericum perforatum	1.31	0.16	1.47
Lupinus rivularis	7.84	2.96	10.80
Festuca myuros	1.31	0.37	1.68
Rumex acetosella	4.57	0.24	4.81
Pteridium aquilinum	0.65	0.54	1.19
Arabidopsis thaliana	1.31	0.08	1.39
Poa nemoralis	1.96	4.84	6.80
Antennaria sp.	0.65	0.03	0.68
Plantago lanceolata	3.27	1.45	4.72
Trifolium dubium	1.31	2.05	3.36
Lathyrus japonicus	1.31	2.69	4.00
Festuca arundinacea	1.31	1.51	2.82
Vicia cracca	1.96	0.48	2.44
Crepis nicaeensis	0.65	0.03	0.68
Myosotis discolor	0.65	0.03	0.68
Lichens	3.92	7.97	11.89
Mosses	12.42	40.83	53.25

Table 4

Relative Frequency, Relative Dominance, and Importance Values of Plant Species Present in Terrestrial Quadrats During June Sampling Period (20-24 June 1975)

Species	Relative Frequency	Relative Dominance	Importance Value
Equisetum hyemale	11.41	5.86	17.27
Holcus lanatus	11.41	9.50	20.91
Hypochaeris radicata	10.07	1.17	11.24
Aira caryophyllea	9.39	3.78	13.17
Aira praecox	2.01	0.11	2.12
Poa nemoralis	5.37	5.01	10.38
Cerastium nutans	4.70	0.28	4.98
Anaphalis margaritacea	1.34	0.88	2.22
Hypericum perforatum	1.34	0.17	1.51
Lupinus rivularis	8.72	6.12	14.84
Crepis nicaeensis	3.35	0.40	3.75
Festuca myuros	1.34	1.42	2.76
Rumex acetosella	5.37	0.28	5.65
Pteridium aquilinum	0.67	1.71	2.38
Antennaria sp.	0.67	0.03	0.70
Plantago lanceolata	2.68	0.46	3.14
Trifolium dubium	2.01	3.21	5.22
Lathyrus japonicus	1.34	4.95	6.29
Festuca arundinacea	1.34	1.19	2.53
Vicia cracca	0.67	0.03	0.70
Trifolium pratense	0.67	0.06	0.73
Lichens	3.35	8.08	11.43
Mosses	10.74	45.35	56.09

Wetland Species Distribution

The elevational limits of distribution (range) above MLLW of the major species are presented in Table 5. These determinations are based on approximately 200 sample locations, many of which contained more than one plant species. The vertical range in which the species occurred as a dominant or codominant is also presented, as well as the range occupied by luxuriant stands of the species concerned.

Lyngby's sedge *(Carex lyngbyei)* has the broadest range in terms of the elevational gradient. This may be partially a result of the successional attributes of this species as reported by Jefferson (1974). This sedge generally forms a zone between the common spike-rush *(Eleocharis palustris)* at lower elevations and tufted hairgrass *(Deschampsia cespitosa)* at higher elevations. Above the tufted hairgrass is a zone of reed canarygrass *(Phalaris arudinacea)* or willows *(Salix* spp.*)* or both. However, as the results of the elevational distribution portion of this study demonstrate, this is not rigid. Samples taken on the wetlands off the eastern end of the main island indicated that certain species were found at lower elevations there than in the cove on the north side of the island. These observations indicate that the present distribution of wetland species is related to other parameters than height above MLLW, although this seems to predominate. These parameters undoubtedly include community age and successional status, substrate composition, and rate of sediment accretion or erosion.

Since no elevational sample points were located in or above the willow zone, it should be emphasized that both tufted hairgrass and reed canarygrass have broader amplitudes than these data suggest. They are both capable of successful establishment above the intertidal zone, as both species were observed and collected in the sandspit areas.

Table 5

Elevational Distribution of Wetland Species*

Species	Number of Samples	Elevational Distribution		
		Range	Present as Dominant or Codominant	Luxuriant Stands
Eleocharis palustris	101	1.8-5.1	1.9-4.6	2.1-4.0
Carex lyngbyei	95	1.5-7.0	2.1-5.5	2.7-5.5
Deschampsia cespitosa	66	2.6-7.1	3.3-6.8	3.7-5.2
Unidentified *Juncaceae*	28	2.2-4.6	2.2-4.6	2.5-4.0
Phalaris arundinacea	18	2.6-7.4	3.8-7.4	6.5-7.4
Scirpus validus	10	2.4-4.2	-	-
Lilaeopsis occidentalis	8	1.4-4.5	-	-
Potentilla pacifica	6	4.7-6.8	-	-
Callitriche verna	5	2.9-4.0	-	-
Juncus balticus	2	4.3-6.4	-	-

*Elevations given in feet above MLLW

-No data

Wetland Quadrat Information

The data presented in Tables 6, 7, and 8, together with qualitative field observations, indicate that three species commonly occur as dominants or codominants in the wetlands. These three species are common spike-rush *(Eleocharis palustris)*, Lyngby's sedge *(Carex lyngbyei)*, and tufted hairgrass *(Deschampsia cespitosa)*. Occasionally, reed canarygrass *(Phabris arundinacea)* appears as a dominant in localized areas above the tufted hairgrass zone.

Other species found in the quadrats are lilaeopsis (*Lilaeopsis occidentalis*), yellow monkey-flower (*Mimulus guttatus*), creeping buttercup (*Ranunculus flammula*), and spring water-starwort (*Callitriche verna*).

Other species of buttercups, water-cress (*Rorippa nasturtium-aquaticum*), tule (*Scirpus validus*), Baltic rush (*Juncus balticus*), white bog-orchid (*Habenaria dilatata*), and western marshmarigold (*Caltha asarifolia*) are found occasionally in the wetlands. Pacific silverweed (*Potentilla pacifica*) occurs commonly in the upper portion of the tufted hairgrass zone and above in the zone of willows.

The data in Tables 6, 7, and 8 also demonstrate the rapid growth of the dominant species of the wetland vegetation between the April and June sampling periods. Percent cover of individual species increased during this interval, and as a result the percentage of bare ground in the quadrats decreased.

Although not included in the quadrats, several hummocks of vegetation were observed in the cove. Species on these hummocks appeared to vary according to elevation above MLLW, although no actual elevational determinations were made. Common spike-rush and Lyngby's sedge were observed as dominants on these hummocks, as well as some tufted hairgrass. These hummocks appear similar to those described by Johannessen (1964) and Redfield (1972) and implied by both authors to be important in the natural expansion of marsh vegetation in any given region of a mud or sand flat.

Other observations indicated that the intertidal sandy areas at the east end of the cove are capable of supporting both Lyngby's sedge and

Table 6

Percent Cover of Plant Species Present in Aquatic Quadrats During April Sampling Period (23-29 April 1975)

Species	Percent Cover by Quadrat Number									
	1	2	3	4	5	6	7	8	9	10
Carex lyngbyei	1	25	tr*		5	15	40	5	1	
Deschampsia cespitosa	40		50		2	10	2			15
Eleocharis palustris	1	tr		5	1	tr	2	2	20	10
Mimulus guttatus†	5	tr	1		tr	tr	tr	tr		tr
Eryngium petiolatum†	tr									
Lilaeopsis occidentalis		tr		tr				tr		
Ranunculus flammula†					30					
Phalaris arundinacea						tr		40		
Unidentified *Juncaceae*										2
Miscellaneous seedlings		tr			10					
Moss	tr	tr	1			2	tr			
Bare ground	50	75	50	95	50	70	55	50	80	70

*Trace (i.e., less than 1 percent cover)

†Tentative identification

Table 7

Percent Cover of Plant Species Present in Aquatic Quadrats
During May Sampling Period (23-26 May 1975)

Species	Percent Cover by Quadrat Number									
	1	2	3	4	5	6	7	8	9	10
Carex lyngbyei	3	75	1		5	40	70	5	1	
Deschampsia cespitosa	65		50		2	3				20
Mimulus guttatus†	5	1				tr*	tr	tr	tr	
Eryngium petiolatum†	1	2	1		1	tr	tr	2		tr
Lilaeopsis occidentalis	1	tr		tr				2		2
Eleocharis palustris				50	2			1	45	5
Ranunculus flammula†					1		tr			
Phalaris arundinacea								45		
Unidentified *Juncaceae*										2
Miscellaneous seedlings	tr				15				tr	
Algae			1			tr				
Bare ground	25	25	50	50	75	55	30	45	55	70

*Trace (i.e., less than 1 percent cover)

†Tentative identification

Table 8

Percent Cover of Plant Species Present in Aquatic Quadrats During June Sampling Period (20-24 June 1975)

Species	Percent Cover by Quadrat Number									
	1	2	3	4	5	6	7	8	9	10
Carex lyngbyei	10	75	5		20	85	90	5		
Deschampsia cespitosa	80		45		10	5	2			15
Mimulus guttatus†	2	1	3		tr*	3	2	5	tr	
Eryngium petiolatum†	2	1	1			1				tr
Lilaeopsis occidentalis	1			tr		2		5	2	5
Callitriche verna		3			tr			5	2	tr
Phalaris arundinacea			5					55		
Eleocharis palustris				60	10			10	85	40
Ranunculus flammula†					5	1	1	5		
Unidentified *Juncaceae*					2			2		3
Miscellaneous seedlings					3					
Bare ground	5	20	40	40	50	3	5	10	10	35

*Trace (i.e., less than 1 percent cover)

†Tentative identification

tufted hairgrass. Some propagules of tufted hairgrass appear to have become established during the current growing season. However, erosional action had dislodged a portion of these young individuals by 8 August 1975.

Productivity Estimates

Since the number of wetland clip-plots utilized during this study was small (four) and the time limits of the study did not encompass an entire year, a strict application of the Wiegert-Evans method was not appropriate here (Wiegert and Evans 1964). The modified method as proposed by Lomnicki et al. (1968) can be appropriately used only when dead vegetation does not disappear promptly after its death, i.e., between sampling periods. This almost certainly does not hold for wetlands under tidal influence. Field observations indicate that dead material of some species, in particular Lyngby's sedge and common spike-rush, does not remain long but shatters easily and is flushed from the plots by the tides and river currents. Plant material foreign to the sample plots may also be deposited on them by these same forces.

More frequent sampling could minimize the effects of these parameters. Kelly et al. (1974) have suggested that intervals as brief as one week should be utilized with the Wiegert-Evans type of productivity estimate in grasslands. The modified method of Lomnicki et al. (1968) requires an interval brief enough to prevent the disappearance of material that has died during the interval, and such an interval depends upon the particular community being sampled.

These limitations must be recognized even though the productivity estimates were done not to provide a definitive study of wetland production but to give a first approximation of productivity of the dominant species during a limited time period with a limited number of samples.

The biomass determinations from the four clip-plots represent four different environmental situations, although Lyngby's sedge was present in each clip-plot.* A minimum productivity estimate based

*The locations of these clip-plots in reference to the main island and the sandspit are given in Figure 2.

on these data for Clip-Plot 1 through the June sampling period is 1015 g/m^2, if peak standing crop of living material is considered (Table 9). Similarly, for Clip-Plots 2, 3, and 4 the estimates are 208, 460, and 308 g/m^2, respectively. These estimates are within the lower range for estuaries and saltwater marshes as reported by Keefe (1972).

These minimum estimates can be adjusted upward by consideration of the difference between dead material present during the April sampling period and that present during the June sampling period. The underlying assumption is that an increase in dead material between the sampling periods represents material added to this category from the living component during the time interval (Lomnicki et al. 1968). This consideration would increase the estimates for Clip-Plot 1, 2, and 4 by approximately 5 percent.

Clip-Plot 1 is the most productive of the four, when total production of the plot is considered or when the two dominant species are examined individually and compared with those species in the other clip-plots. The causal reasons for this phenomenon are unknown, but are probably related to the presumed older age of the stand and chemical and physical composition of the underlying substrate.

Rare and Endangered Species

Three species found on Miller Sands are presently included on Oregon's list of rare and endangered plants (Conference on Rare and Endangered Plants in Oregon, March 1976, unpublished). These are *Amorpha canescens* (leadplant), *Eryngium petiolatum* (Oregon coyote-thistle), and *Salix drummondiana* (Drummond willow). *Salix fluviatilis* (Columbia River willow), while presently on the Smithsonian Institution's (1975) list of "threatened" species in Washington and Oregon, has been removed from Oregon's list.

Table 9

Biomass Determinations from the Wetland Clip-Plots

Clip-Plot Number	Species	Dry Weight (g/m^2)		
		April	May	June
1	*Carex lyngbyei*	9.56	49.80	346.98
1	*Deschampsia cespitosa*	42.28	149.44	539.90
1	Unidentified *Juncaceae*	—	—	42.27
1	Miscellaneous*	20.72	40.80	85.46
1	Dead plant material	70.08	91.08	124.25
2	*Carex lyngbyei*	16.56	90.80	127.54
2	Unidentified *Juncaceae*	—	—	74.59
2	Miscellaneous*	2.32	1.44	5.56
2	Dead plant material	4.44	3.84	11.85
3	*Carex lyngbyei*	1.48	17.40	17.25
3	*Deschampsia cespitosa*	56.80	157.44	303.92
3	*Eleocharis palustris*	—	—	5.32
3	Miscellaneous*	8.04	35.00	133.69
3	Dead plant material	104.56	137.20	70.74
4	*Carex lyngbyei*	—	12.88	23.55
4	*Eleocharis palustris*	8.20	73.28	279.06
4	Miscellaneous*	0.52	2.36	4.89
4	Dead plant material	0.24	1.04	15.60

*Includes algae and moss

FAUNA

Mammals Captured

Between 25 and 27 April 1975, no mammals were captured in 24 trap nights of sampling with snap traps; but four Norway rats *(Rattus norvegicus)* were captured in 50 trap nights of sampling with Smith live traps. Rats were captured in habitats containing moist soil under dense stands of cottonwood and dogwood and near burrows in the grassland. Norway rats probably occur throughout the island in wooded habitat containing moist soil where woodlots, driftwood, stumps, or logs provide denning habitat. Ten rat burrows were observed along 900 metres of Transect 1, while two burrows were observed along Transect 3. Two burrows were observed in the grassland region.

Between 23 and 26 May 1975, 735 trap nights of effort with museum special snap traps yielded no captures within the sample grids. One Townsend's vole *(Microtus townsendii)* was taken from a colony located near, but not within, Grid 3, which was in the grassland. Three species of small mammals were captured during the third sampling period (20-24 June 1975). Five Townsend's voles, three Trowbridge's shrews *(Sorex trowbridgii)*, and one deer mouse *(Peromyscus maniculatus)* were captured in 735 trap nights of effort. Seven of the nine mammals captured were taken in Grid 5, which was placed in a riparian habitat dominated by rush but containing alder, Scot's broom, black cottonwood, logs, and decaying driftwood. The deer mouse was taken in Grid 2, which was placed in old cottonwood and alder habitat with western hemlock and scouring-rush understory. One vole was taken in Grid 3, which was located in the scouring-rush and velvetgrass habitat. Reconnaissance of habitats on the island indicated that several additional vole colonies occurred where dense grass, rush, or scouring-rush and velvetgrass provided a canopy and food and where accumulated litter provided cover for burrows and runways. Because only nine small mammals were captured in 1470 trap nights of effort during the second and third sampling periods, numbers of small mammals on the island are believed to be limited.

Mammals Observed

Mammals observed during sampling periods included nutria *(Myocaster coypus)* and harbor seals *(Phoca vitulina)*. Five to eight nutria were observed daily during each sampling period. Two distinct sizes of animals were observed. The larger animals were believed to be adults, while smaller nutria were considered juveniles. Juveniles were approximately two-thirds the size of adults. No live kit nutria were observed, although the remains of one apparently taken by avian predators was found 23 June 1975. According to Peloquin (1969), peaks in births of nutria in the Willamette Valley, Oregon, occur in January, March, and May. If kits were born during those months on Miller Sands Island, their presence should have been noticed during sampling periods in April, May, and June. Reasons for their apparent absence are unclear, but low reproductive success could be one explanation.

Observations of active nutria trails on the main island and of fresh tracks in the marsh and on the sandspit indicated that nutria utilized all habitats on the island. Active travel routes were noted more frequently in the south shore and north shore habitat types than in the grassland. Nutria appeared to utilize brushy habitats for resting, denning, and feeding. Marsh and grassland habitats probably were utilized only for feeding purposes. Three to five sets of tracks were observed on the sandspit during each sampling period. However, nutria did not appear to utilize the barley that was maturing on the sandspit, perhaps because more palatable forage was available in abundance in the intertidal marsh.

The large cottonwood woodlots on the south shore of the island apparently provide daytime habitats for much of the nutria population. Nutria disperse from these woodlots during the night to forage. Although some disperse in all directions, tracks, trails, clipped vegetation, and direct observations of nutria indicate the majority of animals move to the marshes located to the north and east of the main island. During

all sampling periods several nutria were observed returning to the island from upriver several hours after nutria on the island had ceased to forage in open areas (marshlands and grasslands). These traveling animals probably moved upriver to forage in marshes east of Miller Sands Island during the night and returned to the island as the flooding tide covered the marshes.

Two harbor seals were observed near Miller Sands Island on 16 March 1975, and one seal was observed in the cove near the western tip of the sandspit during the first and third sampling periods. These animals appear to be occasional visitors to the island. Pearson and Verts (1970) were uncertain of the origin of the few seals they observed in the Columbia River. Because they sighted seals in the river on only 10 of 31 days that surveys were conducted, they believed that harbor seals did not reside in the river permanently. They further stated that the nearest suitable habitats for harbor seals were at Tillamook Head, Oregon, and Willapa Bay, Washington. Both areas are about 25 miles from the mouth of the Columbia.

Avifauna

Avian censuses were conducted in each of five different habitat types between 6:00 a.m. and 11:00 a.m. during each of the sampling periods. Times that censuses were conducted varied as a response to weather conditions and times that low tides occurred. Weather conditions were generally not optimal for avian activity. Wind, rain, or both wind and rain occurred during the times that censuses were being taken. Weather-induced inactivity of avifauna probably was responsible for reducing numbers of observations of certain birds. For example, during the last sampling period several species of warblers, black-headed grosbeaks *(Pheuticus melanocephalus)*, Swainson's thrushes *(Catharus ustulatus)*, and willow flycatchers *(Empidonax traillii)* were seen on the island, but not recorded during censuses.

Sixty-five different species of birds were observed on Miller Sands Island and in adjacent waters and wetlands during this study (Table 10). Forty-eight, 32, and 33 different species were observed during the first, second, and third sampling periods, respectively (Table 10). Changes in numbers and species of birds observed from April to June were attributed to the emigration of species of waterfowl and shorebirds observed in April and the immigration of additional passerine birds in May and June. In April, waterfowl and shorebirds apparently utilized Miller Sands Island for nesting and feeding purposes and then continued northward. Twenty species of these birds were observed in April, while 11 were recorded in May and 4 species observed in June. Changes in numbers of passerine birds were not so dramatic, as 18, 16, and 21 species were recorded in April, May, and June, respectively.

Twenty-eight, 20, and 24 species of birds were observed during censuses conducted during April (Table 11), May (Table 12), and June (Table 13), respectively. Some species were observed in more than one habitat type. However, a distinctly different grouping of birds was observed in each habitat type (Tables 11, 12, and 13), indicating habitat preferences.

Numbers of bird species present were highest on Miller Sands Island in April, followed by June and May in descending order (Tables 11-14). As previously stated, this was due to large numbers of waterfowl and shorebirds recorded in April. Numbers of observations were higher in the intertidal marsh, followed by the sandspit, grassland, north shore, and south shore (Table 14). More species were observed on the south shore, north shore, and intertidal marsh than the sandspit and grassland (Table 14).

Bird species diversity (BSD) tended to fluctuate (Table 14) because small sample sizes, emigration, immigration, and territorial behavior of birds influenced both species richness and relative abundance parameters of the index. However, although indices were variable, general trends were established. BSD tended to be highest in the south

Table 10

Species of Birds Observed on Miller Sands Island and Adjacent Waters During Sampling Periods* in April, May, and June 1975

Species	Sampling Period*		
	1	2	3
Common loon	X	X	
Western grebe	X		
Horned grebe	X		
Double-crested cormorant		X	
Great Basin Canada goose	X		X
Dusky Canada goose	X		
Mallard	X	X	X
Pintail	X	X	
American wigeon	X	X	
American green-winged teal	X		
Northern shoveler		X	
Lesser scaup	X		
White-winged scoter	X		
Surf scoter	X		
Common merganser	X		
Red-breasted merganser	X		
Turkey vulture	X	X	
Red-tailed hawk	X	X	
Marsh hawk			X
Bald eagle	X	X	X
Great blue heron	X	X	X
Black-bellied plover	X		
Semipalmated plover	X		
Snowy plover		X	

*Sampling periods: 1, 23-29 April; 2, 23-26 May; and 3, 20-24 June 1975

(Continued)

Table 10 (continued)

Species	Sampling Period 1	2	3
Killdeer	X	X	X
Whimbrel		X	
Dunlin	X		
Western sandpiper	X	X	
Common snipe	X		
Glaucous-winged gull	X	X	X
Western gull	X		
Herring gull	X		X
California gull	X		X
Ring-billed gull		X	X
Mew gull			X
Bonaparte's gull	X		
Caspian tern	X		X
Rufous hummingbird	X		X
Yellow-bellied sapsucker (red race)	X		
Hairy woodpecker	X		X
Willow flycatcher			X
Western kingbird		X	
Barn swallow	X	X	X
Cliff swallow	X	X	X
Violet-green swallow	X	X	X
Tree swallow	X	X	X
Common raven		X	
Common crow	X	X	X
Black-capped chickadee	X	X	X
Bewick's wren	X		
American robin	X		X

(Continued)

Table 10 (concluded)

Species		Sampling Period 1	2	3
Swainson's thrush				X
Starling		X		X
Black-throated gray warbler				X
Orange-crowned warbler		X	X	
Yellow-rumped warbler		X		
Yellow warbler			X	
Wilson's warbler			X	X
Brown-headed cowbird		X	X	X
Black-headed grosbeak				X
American goldfinch			X	X
Savannah sparrow		X	X	X
White-crowned sparrow		X	X	X
Fox sparrow				X
Song sparrow		X	X	X
TOTAL	65†	48	32	33

†Total number of species observed during sampling periods

Table 11

Species of Birds Observed During Censuses
Conducted 23-29 April 1975 Along Transect Lines
Established in Each of Five Different Habitat Types

Species	Number of Observations, by Habitat Type*				
	1	2	3	4	5
Common crow	7				
Yellow-rumped warbler	2				
Bewick's wren	2				
Black-capped chickadee	2				
Brown-headed cowbird	4				
Yellow-bellied sapsucker	2				
Mallard	1		1		
Song sparrow	4		10		
Rufous hummingbird	1		1		
White-crowned sparrow	2	2	2		
Savannah sparrow		8	1		
Killdeer		2			
Cliff swallow		15	1	2	6
Tree swallow		50	4	108	27
Barn swallow		1	1	1	1
American robin			2		
Bald eagle			1		
Orange-crowned warbler			1		
Western sandpiper				36	38
Dunlin				32	46
Herring gull				1	1
Common loon				1	
Glaucous-winged gull				2	

*Habitat types: (1) south shore, (2) grassland, (3) north shore, (4) intertidal marsh, and (5) sandspit

(Continued)

Table 11 (concluded)

Species		Number of Observations, by Habitat Type				
		1	2	3	4	5
Black-bellied plover					2	
Semipalmated plover					3	
Horned grebe					1	
California gull						1
Caspian tern						4
TOTAL	28†	27	78	25	189	124

†Total number of species observed during April censuses

Table 12

Species of Birds Observed During Censuses
Conducted 23-26 May 1975 Along Transect Lines
Established in Each of Five Different Habitat Types

Species		Number of Observations, by Habitat Type*				
		1	2	3	4	5
Yellow warbler		2				
Western kingbird		1				
Wilson's warbler		5		10		
Song sparrow		3		16		
Mallard		4		1		
Common crow		4		1	5	1
Tree swallow		5			3	2
Barn swallow		5			4	29
Cliff swallow		4	1			3
Brown-headed cowbird		1	6	3		
White-crowned sparrow		1	1	3		
American goldfinch			3	1	2	
Savannah sparrow			8			
Glaucous-winged gull				1		2
Orange-crowned warbler				2		
Ring-billed gull					1	
American wigeon					3	
Snowy plover					1	
Killdeer					3	
Violet-green swallow						1
TOTAL	20†	35	19	28	22	38

*Habitat types: (1) south shore, (2) grassland, (3) north shore, (4) intertidal marsh, and (5) sandspit

†Total number of species observed during May censuses

Table 13

Species of Birds Observed During Censuses Conducted 20-24 June 1975 Along Transect Lines Established in Each of Five Different Habitat Types

Species	Number of Observations, by Habitat Type*				
	1	2	3	4	5
Hairy woodpecker	1				
Swainson's thrush	2				
Black-throated gray warbler	2				
Willow flycatcher	2				
American robin	1				
Fox sparrow	1				
Song sparrow	1		3		
Common crow	1	5	2	7	8
Barn swallow	2	1	12	14	2
Tree swallow	2	1	6	6	5
Brown-headed cowbird	1		2		
Savannah sparrow		1	1		
Killdeer		2		3	
Cliff swallow		1		6	2
White-crowned sparrow		1			
American goldfinch		1			
Rufous hummingbird			1		
Starling			10		
Violet-green swallow				1	
California gull				1	
Herring gull				2	2
Ring-billed gull				9	10
Glaucous-winged gull				1	6
Caspian tern					1
TOTAL 24**	26	23	37	50	36

*Habitat types: (1) south shore, (2) grassland, (3) north shore, (4) intertidal marsh, and (5) sandspit

**Total number of species observed during June censuses

Table 14

Number of Different Species, Number of Observations, and Bird Species Diversity Index* in Each of Five Habitat Types on Miller Sands Island During Sampling Periods in April, May, and June 1975†

Habitat Type	No. of Species			No. of Observations			Species Diversity		
	April	May	June	April	May	June	April	May	June
South shore	10	11	11	27	35	26	2.12	2.24	1.96
Grassland	6	5	8	78	19	23	1.06	1.08	1.57
North shore	11	9	8	25	28	37	1.96	1.83	1.72
Intertidal marsh	11	8	10	189	22	50	1.24	1.95	1.98
sandspit	8	6	8	124	38	36	1.43	0.90	1.83

*Shannon and Weaver 1949

†Sampling periods: 23-29 April, 23-26 May, and 20-24 June 1975

shore habitat, the intertidal marsh and north shore intermediate, and grassland and sandspit lowest (Table 14). Higher BSD in the south shore habitat occurred because this community is more stratified than other habitats, providing habitat for birds on the ground, understory vegetation, canopy, snags, and air space. The grassland and sandspit habitats, being the youngest seral stages, had the lowest BSD.

BSD usually increases with the maturity of the successional stage of the habitat (Odum 1971; Kricher 1972, 1973; Tramer 1969; and Shugart and James 1973), and is largely determined by the species richness component of the diversity index (Kricher 1972, Tramer 1969). Generally, the community containing the largest number of species also has the highest diversity index. Relative abundance of species of birds influences the index to a lesser extent.

Species of birds found nesting on the island included mallard, Great Basin Canada goose, killdeer *(Charadrius vociferus)*, song sparrow *(Melospiza melodia)*, white-crowned sparrow *(Zonotrichia leucophrys)*, and common crow *(Corvus brachyrhynchos)*. Eight mallard nests and one goose nest were found on the island during April. Some late-nesting mallards were observed on the island in May. One hen was observed setting on a partially prepared nest that contained no eggs. Other pairs of mallards were observed in the cove. Their presence suggested that they may have been late-nesting birds as well.

Apparently, the eggs in nests of ducks and geese that were found during the first sampling period hatched successfully. Shells of eggs of both mallards and Canada geese were found in the vicinity of nest locations in May. Two mallard hens with broods were observed. No geese broods were observed. It is likely that the geese and many of the ducks moved their broods to other islands in the region.

Nesting success of other birds was not determined. However, subjective evidence suggested it to be at least partially successful.

Juvenile song sparrows and white-crowned sparrows were observed on several occasions.

Between one and four bald eagles *(Haliaeetus leucocephalus)* were observed each sampling period. Most of the birds were observed soaring over the island or adjacent waters. However, on two occasions, bald eagles were observed perched in black cottonwood snags on the east end of the island.

Amphibians and Reptiles

No amphibians or reptiles were observed during a search of suitable habitats. Logs and driftwood were displaced and rotten logs and stumps were dismantled, but no amphibians or reptiles were found. Previously, during other sampling activities, two species of snake, the red-spotted garter snake *(Thamnophis sirtalis concinnus)* and the northwestern garter snake *(Thamnophis ordinoides)*, had been observed along the north shore of the island.

Rare and Endangered Species

No species of animals presently included on the list of threatened (USDI 1973) or endangered (USDI 1974) species were observed on or in the vicinity of Miller Sands Island. Several species of birds were observed that are considered rare or endangered in Oregon (Marshall 1969). At least four northern bald eagles were observed on or near Miller Sands Island. The Oregon Department of Fish and Wildlife (ODF&W) considers this bird threatened and reports 61 active nest sites in the state (List of species considered rare or endangered in Oregon, ODF&W [unpublished], 1975).

One western snowy plover *(Charadrius alexandrinus nivosus)*, classified as rare in Oregon by Marshall (1969) and as threatened by the ODF&W, was observed on a mud flat on the northern shore of Miller Sands Island during May. This bird is a permanent resident of the Oregon coast (ODF&W,

unpublished). Approximately 50 pairs nest in eastern Oregon (Marshall 1969) and 80 to 100 pairs nest on the Oregon coast (ODF&W, unpublished).

Other birds receiving classified status by Marshall (1969) that were observed on Miller Sands Island were the horned grebe *(Podiceps auritus)* and the Caspian tern *(Sterna caspia)*. The horned grebe is classified as peripheral, as Oregon is on the periphery of the bird's breeding range. Marshall (1969) considers the Caspian tern rare in Oregon. It nests in Klamath, Lake, and Harney counties of southeastern Oregon. Since Marshall's (1969) work, 169 nests were counted on a sand island in the John Day pool of the Columbia River (OCWRU 1974).

Pestiferous Species

Absolute abundance of Norway rats is not known, but they are apparently distributed in all habitat types on the main island.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The vegetative communities and associated wildlife of Miller Sands Island have some attributes similar to those of communities found at other locations along the lower Columbia River, while other attributes are related to coastal sand dune habitats.

Based on qualitative field observations, data obtained from terrestrial and aquatic quadrats, and photographic documentation, it is apparent that the communities described in this report are successional. Primary pioneer succession is occurring on the sandspit areas and in intertidal sand and mud flats. The marsh vegetation shows evidence of the encroachment of various willows. The open grassland area on the main island is gradually becoming a woodland with the establishment of Oregon alder, black cottonwood, Douglas fir, and other conifers. The present wooded areas of Oregon alder and black cottonwood contain younger individuals of Sitka spruce, western hemlock, and western red cedar in the understory. These coniferous species have the ecological potential of establishing climax communities on large portions of Miller Sands Island.

Miller Sands Island provides resting space for waterfowl during the spring and fall migrations. The island is utilized by mallards and Great Basin Canada geese for nesting. Changes in habitat, either through natural succession or through artificial manipulation, will cause a shift in the species of birds and their abundances.

Apparently, mammals, amphibians, and reptiles have not colonized the island as rapidly as birds have. Colonization by nonavian vertebrates is obviously more difficult because modes of reaching the island by crossing a broad expanse of water are limited to swimming and rafting. Apparently, the most successful mammalian colonizer is the nutria. Nutria would be expected to reach an island prior to nonaquatic mammals.

It is unclear why so few species of amphibians and reptiles occur on the island, especially because at least part of the life cycle of many of these vertebrates requires water. Perhaps the daily tidal cycle of the lower Columbia River inhibits reproduction in amphibians and discourages colonization by aquatic reptiles.

RECOMMENDATIONS

If present management plans include alteration of the existing habitats to enhance waterfowl production, it is recommended that nesting surveys be conducted on both control and experimental plots to evaluate the results of habitat manipulation. Numbers of nesting waterfowl utilizing both newly established and control habitats should be monitored over a period of years to help determine results of management programs.

If management objectives require control of the nutria population, both the positive and the negative effects of nutria activities on the vegetation of the island should be carefully considered. From qualitative observations, it is the authors' opinion that nutria help to maintain a preclimax successional state on Miller Sands Island and its associated wetlands by clipping herbaceous and woody vegetation during certain periods of the year. Further, the authors believe that the nutria may have an overall beneficial influence by maintaining the wetlands as a marsh rather than allowing a willow-shrub community to develop.

Prior to implementation of a nutria control program, it is strongly recommended that studies be carried out to determine the following: (1) the reproductive status of nutria using the island, (2) the extent of the population utilizing the island, (3) the extent of movement of nutria between Miller Sands Island and nearby islands, and (4) the total impact of nutria on the vegetation of the island. Any chemical control programs for nutria should include consideration of possible effects on the bald eagle population through secondary poisoning and the possibility that artificial control of specific animal species on a national wildlife refuge may violate the purpose of the National Wildlife Refuge System.

It is strongly recommended that data collection for future wetland productivity studies be continued through the entire year to improve on estimates presented in this study; preferably biweekly samplings during the growing season (April-August) and monthly samplings during the remainder of the year, as suggested by Kelly et al. (1974) and Lomnicki et al. (1968). In addition, future collection of voucher specimens should continue through July, August, and September to obtain a more complete inventory of species in both terrestrial and wetland habitats.

It is recommended that the small isolated hummocks of vegetation in the cove be examined in more detail to ascertain their elevation, successional status, and rate of expansion as indicators of natural marsh propagation. Related to this, to natural and artificial propagation of the entire wetland vegetation, and to its expansion onto the mud flat areas, it is recommended that a series of low-elevation aerial color-infrared photographs be taken in mid-July 1976 and at a similar time during the later phases of the overall program.

In planting the proposed experimental marsh in the cove, it is recommended that the dominant species listed in Table 5 be planted in the elevational range where they appear as dominants or codominants in the existing vegetation. However, both tufted hairgrass *(Deschampsia*

cespitosa) and tall fescue *(Festuca arudinacea)* could be planted at higher elevations than their ranges indicate, as they both occur naturally on the top of the sandspit at the east end of the cove.

The experimental marsh, as well as a control area that would allow natural establishment to occur, should be monitored for a minimum period of two years; three or four years would be preferable.

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Appendix A

SPECIES LIST: FLORA

Table A1

Plant Species Observed on the Miller Sands Island Complex

Common Name	Family and Scientific Name
	Aceraceae
Big-leaf maple*	*Acer macrophyllum* Pursh.
	Aquifoliaceae
Holly	*Ilex* sp.
	Betulaceae
Oregon alder	*Alnus rubra* Bong.
	Boraginaceae
Forget-me-not	*Myosotis discolor* Pers.
Common forget-me-not	*Myosotis scorpioides* L.
	Callitrichaceae
Spring water-starwort	*Callitriche verna* L.
	Caprifoliaceae
Black twinberry	*Lonicera involucrata* (Rich.) Banks var. *involucrata*
Red elderberry*	*Sambucus racemosa* L. var. *arborescens* (T. & G.) Gray
Common snowberry	*Symphoricarpos albus* (L.) Blake var. *laevigatus* Fern.
	Caryophyllaceae
Nodding chickweed	*Cerastium nutans* Raf.
	Compositae
Common yarrow	*Achillea millefolium* L. ssp. *lanulosa* (Nutt.) Piper
Pearly everlasting*	*Anaphalis margaritacea* (L.) B. & H.
Everlasting*	*Antennaria* sp.

(Continued)

Note: Nomenclature follows Hitchcock and Cronquist (1973).

* Tentative identification; no voucher specimen collected.

(Continued)

Table A1 (Continued)

Common Name	Family and Scientific Name
	Compositae (continued)
Marguerite	*Chrysanthemum leucanthemum* L.
French hawkweed	*Crepis nicaeensis* Balb.
Philadelphia daisy	*Erigeron philadelphicus* L.
Hairy cats-ear	*Hypochaeris radicata* L.
Wood groundsel	*Senecio sylvaticus* L.
Prickly sow-thistle	*Sonchus asper* (L.) Hill
	Cornaceae
Red-osier dogwood	*Cornus stolonifera* Michs. var. *occidentalis* (T. & G.) Hitchc.
	Cruciferae
Wall cress	*Arabidopsis thaliana* (L.) Schur
American searocket*	*Cakile edentula* (Bigel.) Hook.
Pennsylvania bittercress	*Cardamine pensylvanica* Muhl.
Water-cress	*Rorippa nasturtium-aquaticum* (L.) Schinz & Thell.
Shepherd's cress	*Teesdalia nudicaulis* (L.) R. Br.
	Cupressaceae
Western red cedar	*Thuja plicata* Donn.
	Cyperaceae
Dense sedge	*Carex densa* Bailey
Lyngby's sedge	*Carex lyngbyei* Hornem.
Sawbeak sedge	*Carex stipata* Muhl.
Common spike-rush	*Eleocharis palustris* (L.) R. & S.
Olney's bulrush	*Scirpus olneyi* Gray
Tule	*Scirpus validus* Vahl
	Equisetaceae
Common horsetail	*Equisetum arvense* L.
Common scouring-rush	*Equisetum hyemale* L.

(Continued)

Table A1 (Continued)

Common Name	Family and Scientific Name
	Ericaceae
Bristly manzanita	*Arctostaphylos columbiana* Piper
Bearberry	*Arctostaphylos uva-ursi* (L.) Spreng.
Salal*	*Gaultheria shallon* Pursh
Evergreen huckleberry	*Vaccinium ovatum* Pursh
Red huckleberry	*Vaccinium parvifolium* Smith
	Gramineae
Silver hairgrass	*Aira caryophyllea* L.
Little hairgrass	*Aira praecox* L.
European beachgrass*	*Ammophilia arenaria* (L.) Link.
Barren brome-grass	*Bromus sterilis* L.
Cheat grass	*Bromus tectorum* L.
Tufted hairgrass	*Deschampsia cespitosa* (L.) Beauv. var. *longifolia* Beal
American dunegrass*	*Elymus mollis* Trin.
Tall fescue	*Festuca arundinacea* Schreb.
Rat-tail fescue	*Festuca myuros* L.
Red fescue	*Festuca rubra* L. var. *rubra*
Common velvetgrass	*Holcus lanatus* L.
Barley*	*Hordeum vulgare* L.
Reed canarygrass	*Phalaris arundinacea* L.
Woods bluegrass	*Poa nemoralis* L.
Fowl bluegrass	*Poa palustris* L.
	Hydrocharitaceae
Nuttall's waterweed	*Elodea nuttalli* (Planch.) St. John
	Hypericaceae
Common St. John's-wort	*Hypericum perforatum* L.

(Continued)

Table A1 (Continued)

Common Name	Family and Scientific Name
	Iridaceae
Cultivated iris	*Iris* sp.
	Juncaceae
Baltic rush	*Juncus balticus* Willd. var. *balticus*
	Leguminosae
Lead plant	*Amorpha canascens* Pursh
Scot's broom	*Cytisus scoparius* (L.) Link
Beach pea	*Lathyrus japonicus* Willd.
Marsh peavine	*Lathyrus palustris* L.
Grass peavine	*Lathyrus sphaericus* Retz.
Birdsfoot-trefoil	*Lotus corniculatus* L.
Stream lupine	*Lupinus rivularis* Dougl.
Lance-leaf scurf-pea	*Psoralea lanceolata* Pursh
Least hop clover	*Trifolium dubium* Sibth.
Red clover	*Trifolium pratense* L.
Hop clover	*Trifolium procumbens* L.
White clover	*Trifolium repens* L.
Bird vetch	*Vicia cracca* L.
Giant vetch	*Vicia gigantea* Hook.
Common vetch	*Vicia sativa* L. var. *angustifolia* (L.) Wahlb.
	Liliaceae
False hellebore	*Veratrum californicum* Durand
	Oleaceae
Oregon ash	*Fraxinus latifolia* Benth.
	Onagraceae
Fireweed*	*Epilobium angustifolium* L. (Continued)

Table A1 (Continued)

Common Name	Family and Scientific Name
	Orchidaceae
Rattlesnake plantain*	*Goodyera oblongifolia* Raf.
White bog-orchid	*Habenaria dilatata* (Pursh) Hook. var. *dilatata*
	Pinaceae
Sitka spruce*	*Picea sitchensis* (Bong.) Carr.
Douglas fir*	*Pseudotsuga menziesii* (Mirbel) Franco var. *menziesii*
Western hemlock*	*Tsuga heterophylla* (Raf.) Sarg.
	Plantaginaceae
English plantain	*Plantago lanceolata* L.
	Polygonaceae
Smartweed*	*Polygonum* sp.
Sour weed	*Rumex acetosella* L.
	Polypodiaceae
Lady-fern	*Athyrium filix-femina* (L.) Roth.
Deer-fern	*Blechnum spicant* (L.) Roth.
Sword-fern	*Polystichum munitum* (Kaulf.) Presl var. *munitum*
Bracken	*Pteridium aquilinum* (L.) Kuhn
	Portulacaceae
Water chickweed	*Montia fontana* L. var. *tenerrima* (Gray) Fern. & Wieg.
Western springbeauty	*Montia sibirica* (L.) Howell var. *sibirica*
	Potamogetonaceae
Curled pondweed	*Potamogeton crispus* L.

(Continued)

Table A1 (Continued)

Common Name	Family and Scientific Name
	Ranunculaceae
Western marshmarigold	*Caltha asarifolia* DC.
Meadow buttercup	*Ranunculus acris* L.
Bulbous buttercup	*Ranunculus bulbosus* L.
Creeping buttercup*	*Ranunculus flammula* L.
Macoun's buttercup	*Ranunculus* cf. *macounii* Britt. var. *oreganus* Gray
Straightbeak buttercup	*Ranunculus orthorhynchus* Hook. var. *platyphyllus* Gray
Little buttercup	*Ranunculus uncinatus* D. Don var. *uncinatus*
	Rosaceae
Black hawthorn	*Crataegus douglasii* Lindl. var. *suksdorfii* Sarg.
Indian plum	*Osmaronia cerasiformis* (T. & G.) Greene
Pacific ninebark	*Physocarpus capitatus* (Pursh) Kuntze
Pacific silverweed	*Potentilla pacifica* Howell
Sweet cherry (cultivated)	*Prunus avium* L.
Nootka rose	*Rosa nutkana* Presl var. *nutkana*
Himalayan blackberry	*Rubus discolor* Weike & Ness
Evergreen blackberry	*Rubus laciniatus* Willd.
Thimbleberry	*Rubus parviflorus* Nutt.
Salmonberry	*Rubus spectabilis* Pursh
	Rubiaceae
Pacific bedstraw	*Galium cymosum* Wieg.
	Scrophulariaceae
Foxglove	*Digitalis purpurea* L.
Yellow monkey-flower	*Mimulus guttatus* DC. var. *guttatus*

(Continued)

Table A1 (Concluded)

Common Name	Family and Scientific Name
	Solanaceae
Bittersweet nightshade	*Solanum dulcamara* L.
	Salicaceae
Black cottonwood	*Populus trichocarpa* T. & G.
Drummond willow	*Salix* cf. *drummondiana* Barratt
Coyote willow	*Salix exigua* Nutt. ssp. *exigua* var. *exigua*
Columbia River willow	*Salix fluviatilis* Nutt.
Coast willow	*Salix* cf. *hookeriana* Barratt
Pacific willow	*Salix lasiandra* Benth. var. *lasiandra*
Mackenzie's willow	*Salix rigida* Muhl. var. *mackenzieana* (Hook.) Cronq.
	Umbelliferae
Oregon coyote-thistle*	*Eryngium petiolatum* Hook.
Cow-parsnip	*Heracleum lanatum* Michx.
Lilaeopsis	*Lilaeopsis occidentalis* Coult. & Rose
	Valerianaceae
European corn-salad	*Valerianella locusta* (L.) Betcke

Appendix B

SPECIES LISTS: FAUNA

Table B1

Listing of Mammals Expected to Occur in Suitable Habitat Along the Lower Columbia River*

Common Name	Scientific Name
Virginia opossum	*Didelphis virginiana*
Pacific water shrew	*Sorex bendirii*
Trowbridge's shrew	*Sorex trowbridgii*
Vagrant shrew	*Sorex vagrans*
Dusky shrew	*Sorex obscurus*
Shrew-mole	*Neurotrichus gibbsii*
Townsend's mole	*Scapanus townsendii*
Coast mole	*Scapanus orarius*
Townsend's big-eared bat	*Plecotus townsendii*
Silver-haired bat	*Lasionycteris noctivagans*
Hoary bat	*Lasiurus cinereus*
Big brown bat	*Eptesicus fuscus*
Fringed myotis	*Myotis thysanodes*
Long-eared myotis	*Myotis evotis*
Long-legged myotis	*Myotis volans*
California myotis	*Myotis californicus*
Yuma myotis	*Myotis yumanensis*
Little brown myotis	*Myotis lucifugus*
Brush rabbit	*Sylvilagus bachmani*
Porcupine	*Erethizon dorsatum*
Beaver	*Castor canadensis*
Nutria	*Myocastor coypus*
Townsend's chipmunk	*Eutamias townsendii*
Northern flying squirrel	*Glaucomys sabrinus*
Douglas' squirrel	*Tamiasciurus douglasii*
California ground squirrel	*Spermophilus beecheyi*
Western pocket gopher	*Thomomys mazama*

(Continued)

* Compiled from Hall and Kelson (1959), Ingles (1965), and Verts (1971). Nomenclature follows Jones et al. (1975).

Table B1 (concluded)

Common Name	Scientific Name
Bushy-tailed woodrat	*Neotoma cinerea*
Deer mouse	*Peromyscus maniculatus*
Muskrat	*Ondatra zibethica*
Creeping vole	*Microtus oregoni*
White-footed vole	*Phenacomys albipes*
Red tree vole	*Phenacomys longicaudus*
Western red-backed mouse	*Clethrionomys occidentalis*
Long-tailed vole	*Microtus longicaudus*
Townsend's vole	*Microtus townsendii*
House mouse	*Mus musculus*
Norway rat	*Rattus norvegicus*
Pacific jumping mouse	*Zapus trinotatus*
Bobcat	*Lynx rufus*
Black bear	*Ursus americanus*
Coyote	*Canis latrans*
Gray fox	*Urocyon cinereoargenteus*
Raccoon	*Procyon lotor*
Striped skunk	*Mephitis mephitis*
Eastern spotted skunk	*Spilogale putorius*
Mink	*Mustela vison*
Short-tailed weasel	*Mustela erminea*
Long-tailed weasel	*Mustela frenata*
River otter	*Lutra canadensis*
Northern sea lion	*Eumetopias jubatus*
Harbor seal	*Phoca vitulina*
Elk	*Cervus elaphus*
White-tailed deer	*Odocoileus virginianus leucura*
Black-tailed deer	*Odocoileus hemionus columbiana*

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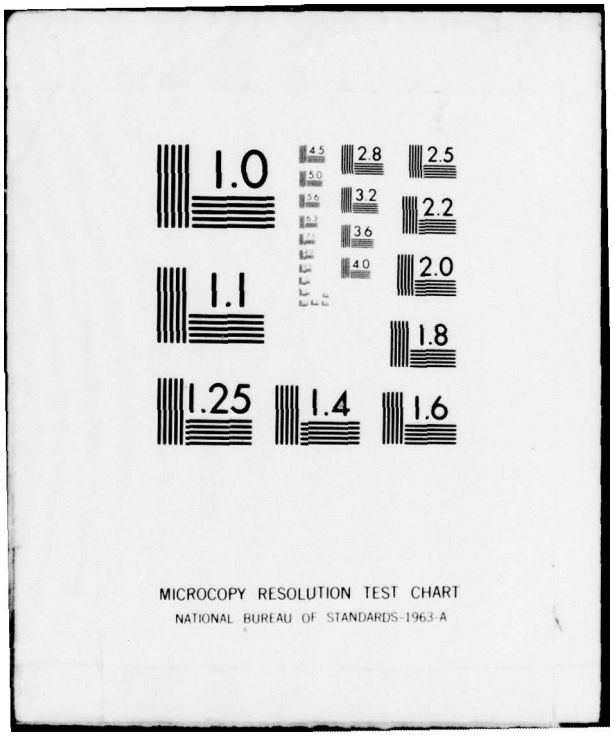
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NATIONAL BUREAU OF STANDARDS-1963-A

Table B2

Birds Expected to Occur in
Northwestern Oregon and Southwestern Washington

Scientific Name	Common Name	Status	Abundance
Gavia immer	Common Loon	R	C
Gavia arctica	Arctic loon	WV	VC
Gavia stellata	Red-throated loon	WV	VC
Podiceps grisegena	Red-necked grebe	R	U
Podiceps auritus	Horned grebe	R	C
Podiceps nigricollis	Eared grebe	R	U
Aechmophorus occidentalis	Western grebe	R	C
Podilymbus podiceps	Pied-billed grebe	R	U
Pelecanus occidentalis	Brown pelican	SV	C
Phalacrocorax auritus	Double-crested cormorant	R	VC
Phalacrocorax penicillatus	Brandt's cormorant	R	VC
Ardea herodias	Great blue heron	R	C
Butorides striatus	Green heron	R	U

(Continued)

Note: List was compiled from Alcorn (1971), Bertrand and Scott (1971), Gabrielson and Jewett (1970), and Masson and Mace (1965).

Birds having occurrence classifications of "hypothetical" and "accidental" are not listed in this table.

Common names are standardized and follow American Ornithologists' Union (1957) *Checklist of North American Birds*, and updates (American Ornithologists' Union 1973, 1976).

Status: R = Resident, found all year
WV = Winter visitor
SV = Summer visitor, nonbreeder
SR = Summer resident, breeds in state
M = Migrant, seen only in transit

Abundance: VC = Very common
C = Common
I = Irregular
U = Uncommon
R = Rare
VR = Very rare
O = Occasional

Table B2 (Continued)

Scientific Name	Common Name	Status	Abundance
Nycticorax nycticorax	Black-crowned night heron	R	U
Botaurus lentiginosus	American bittern	R	U
Anas americana	American wigeon	R	VC
Anas clypeata	Northern shoveler	R	U
Aix sponsa	Wood duck	R	C
Aythya americana	Redhead	R	R
Aythya collaris	Ring-necked duck	R	C
Aythya marila	Greater scaup	WV	U
Aythya affinis	Lesser scaup	R	VC
Bucephala clangula	Common goldeneye	WV	C
Bucephala islandica	Barrow's goldeneye	R	R
Bucephala albeola	Bufflehead	R	C
Clangula hyemalis	Oldsquaw	WV	O
Histrionicus histrionicus	Harlequin duck	R	U
Cygnus olor	Mute swan	WV	U
Olor columbianus	Whistling swan	WV	C
Branta canadensis	Canada goose	R	VC
Branta bernicla nigricans	Black brant	WV	VC
Philacte canagica	Emperor goose	WV	O
Anser albifrons	White-fronted goose	WV	U
Chen caerulescens	Snow goose	WV	U
Anas platyrhynchos	Mallard	R	VC
Anas strepera	Gadwall	R	U
Anas acuta	Pintail	R	VC
Anas carolinensis	Am. green-winged teal	WV	C
Anas discors	Blue-winged teal	R	U
Anas cyanoptera	Cinnamon teal	SR	U
Anas penelope	European wigeon	WV	R
Bonasa umbellus	Ruffed grouse	R	U
Lophortyx californicus	California quail	R	C

(Continued)

Table B2 (Continued)

Scientific Name	Common Name	Status	Abundance
Oreortyx pictus	Mountain quail	R	U
Grus canadensis	Sandhill crane	SR	VC
Rallus limicola	Virginia rail	R	U
Porzana carolina	Sora	SR	U
Fulica americana	American coot	R	VC
Charadrius semipalmatus	Semipalmated plover	M	R
Charadrius alexandrinus	Snowy plover	R	U
Charadrius vociferus	Killdeer	R	VC
Pluvialis dominica	American golden plover	M	U
Pluvialis squatarola	Black-bellied plover	WV	C
Aphriza virgata	Surfbird	WV	C
Capella gallinago	Common snipe	R	C
Melanitta deglandi	White-winged scoter	R	VC
Melanitta perspicillata	Surf scoter	R	VC
Melanitta nigra	Black scoter	R	U
Oxyura jamaicensis	Ruddy duck	R	C
Lophodytes cucullatus	Hooded merganser	R	U
Mergus serrator	Red-breasted merganser	WV	C
Cathartes aura	Turkey vulture	SR	C
Accipiter striatus	Sharp-shinned hawk	R	U
Accipiter cooperii	Cooper's hawk	R	U
Buteo jamaicensis	Red-tailed hawk	R	C
Haliaeetus leucocephalus	Bald eagle	R	U
Circus cyaneus	Marsh hawk	R	C
Pandion haliaetus	Osprey	SR	U
Falco columbarius	Merlin	R	R
Falco sparverius	American kestrel	R	C
Dendragapus obscurus	Blue grouse	R	C
Calidris minutilla	Least sandpiper	WV	VC
Calidris alpina	Dunlin	WV	VC

(Continued)

Table B2 (Continued)

Scientific Name	Common Name	Status	Abundance
Limnodromus griseus	Short-billed dowitcher	M	C
Limnodromus scolopaceus	Long-billed dowitcher	M	VC
Calidris mauri	Western sandpiper	M	VC
Limosa fedoa	Marbled godwit	M	U
Calidris alba	Sanderling	WV	VC
Phalaropus fulicarius	Red phalarope	M	C
Steganopus tricolor	Wilson's phalarope	SR	R
Lobipes lobatus	Northern phalarope	M	VC
Larus hyperboreus	Glaucous gull	WV	R
Larus glaucescens	Glaucous-winged gull	R	VC
Larus occidentalis	Western gull	R	VC
Numenius americanus	Long-billed curlew	SR	R
Numenius phaeopus	Whimbrel	M	U
Actitis macularia	Spotted sandpiper	R	U
Tringa solitaria	Solitary sandpiper	M	R
Catoptrophorus semipalmatus	Willet	SR	R
Tringa melanoleucus	Greater yellowlegs	WV	U
Tringa flavipes	Lesser yellowlegs	M	R
Calidris canutus	Red knot	M	R
Arenarius interpres	Ruddy turnstone	M	U
Arenarius melanocephala	Black turnstone	WV	C
Calidris ptilocnemis	Rock sandpiper	WV	U
Calidris melanotos	Pectoral sandpiper	M	R
Calidris bairdii	Baird's sandpiper	M	R
Bubo virginianus	Great horned owl	R	C
Nyctea scandiaca	Snowy owl	WV	I
Glaucidium gnoma	Pygmy owl	R	C
Strix occidentalis caurina	Northern spotted owl	R	U
Asio otus	Long-eared owl	R	R
Asio flammeus	Short-eared owl	R	U

(Continued)

Table B2 (Continued)

Scientific Name	Common Name	Status	Abundance
Aegolius acadicus	Saw-whet owl	R	U
Chordeiles minor	Common nighthawk	SR	C
Cypseloides niger	Black swift	M	O
Chaetura vauxi	Vaux's swift	SR	C
Aeronautes saxatalis	White-throated swift	SV	VR
Calypte anna	Anna's hummingbird	SV	R
Selasphorus rufus	Rufous hummingbird	SR	C
Selasphorus sasin	Allen's hummingbird	SV	R
Megaceryle alcyon	Belted kingfisher	R	C
Colaptes auratus	Common flicker	R	C
Larus argentatus	Herring gull	R	VC
Larus californicus	California gull	R	VC
Larus delawarensis	Ringed-billed gull	R	C
Larus canus	Mew gull	WV	VC
Larus philadelphia	Bonaparte's gull	M	VC
Rissa tridactyla	Black-legged kittiwake	WV	C
Sterna paradisaea	Arctic tern	SV	U
Sterna caspia	Caspian tern	SR	U
Chlidonias niger	Black tern	SR	R
Columba fasciata	Band-tailed pigeon	SR	C
Columba livia	Rock dove	R	VC
Zenaida macroura	Mourning dove	R	VC
Coccyzus americanus	Yellow-billed cuckoo	SR	VR
Tyto alba	Barn owl	R	C
Otus asio	Screech owl	R	C
Contopus sordidulus	Western wood pewee	SR	C
Nuttallornis borealis	Olive-sided flycatcher	SR	U
Eremophila alpestris	Horned lark	R	C
Tachycineta thalassina	Violet-green swallow	SR	VC
Iridoprocne bicolor	Tree swallow	SR	VC

(Continued)

Table B2 (Continued)

Scientific Name	Common Name	Status	Abundance
Riparia riparia	Bank swallow	SR	U
Stelgidopteryx ruficollis	Rough-winged swallow	SR	R
Hirundo rustica	Barn swallow	SR	VC
Petrochelidon pyrrhonota	Cliff swallow	SR	VC
Progne subis	Purple martin	SR	U
Cyanocitta stelleri	Steller's jay	R	C
Perisoreus canadensis	Gray jay	R	U
Aphelocoma coerulescens	Scrub jay	R	VC
Corvus corax	Common raven	R	U
Corvus brachyrhynchos	Common crow	R	VC
Corvus caurinus	Northwest crow	WV	R
Parus atricapillus	Black-capped chickadee	R	C
Parus rufescens	Chestnut-backed chickadee	R	VC
Psaltriparus minimus	Bushtit	R	VC
Sitta carolinensis	White-breasted nuthatch	R	C
Sitta canadensis	Red-breasted nuthatch	R	C
Certhia familiaris	Brown creeper	R	U
Chamaea fasciata	Wrentit	R	C
Cinclus mexicanus	Dipper	R	U
Troglodytes aedon	House wren	SR	U
Troglodytes troglodytes	Winter wren	R	C
Thryomanes bewickii	Bewick's wren	R	C
Cistothorus palustris	Long-billed marsh wren	R	U
Icteria virens	Yellow-breasted chat	SR	U
Wilsonia pusilla	Wilson's warbler	SR	C
Passer domesticus	House sparrow	R	VC
Sturnella neglecta	Western meadowlark	R	C
Xanthocephalus xanthocephalus	Yellow-headed blackbird	SR	U

(Continued)

Table B2 (Continued)

Scientific Name	Common Name	Status	Abundance
Agelaius phoeniceus	Red-winged blackbird	R	VC
Icterus galbula	Northern oriole	SR	R
Euphagus cyanocephalus	Brewer's blackbird	R	VC
Molothrus ater	Brown-headed cowbird	SR	U
Piranga ludoviciana	Western tanager	SR	C
Pheucticus melanocephalus	Black-headed grosbeak	SR	C
Passerina amoena	Lazuli bunting	SR	U
Hesperiphona vespertina	Evening grosbeak	R	U
Carpodacus purpureus	Purple finch	R	U
Carpodacus mexicanus	House finch	R	C
Carduelis pinus	Pine siskin	R	C
Dryocopus pileatus	Pileated woodpecker	R	U
Melanerpes lewis	Lewis' woodpecker	R	U
Sphyrapicus varius	Yellow-bellied sapsucker	R	U
Picoides villosus	Hairy woodpecker	R	U
Picoides pubescens	Downy woodpecker	R	U
Tyrannus tyrannus	Eastern kingbird	SR	O
Tyrannus verticalis	Western kingbird	SR	O
Empidonax traillii	Willow flycatcher	SR	U
Empidonax hammondii	Hammond's flycatcher	SR	U
Empidonax oberholseri	Dusky flycatcher	SR	U
Empidonax difficilis	Western flycatcher	SR	U
Turdus migratorius	American robin	R	VC
Ixoreus naevius	Varied thrush	R	C
Catharus guttatus	Hermit thrush	R	U
Catharus ustulatus	Swainson's thrush	SR	C
Sialia mexicana	Western bluebird	R	U
Regulus satrapa	Golden-crowned kinglet	R	C
Regulus calendula	Ruby-crowned kinglet	R	U
Anthus spinoletta	Water pipit	R	VC

(Continued)

Table 2 (Continued)

Scientific Name	Common Name	Status	Abundance
Bombycilla garrulus	Bohemian waxwing	WV	I
Bombycilla cedrorum	Cedar waxwing	R	VC
Lanius excubitor	Northern shrike	R	R
Lanius ludovicianus	Loggerhead shrike	R	R
Sturnus vulgaris	Starling	R	VC
Vireo huttoni	Hutton's vireo	R	R
Vireo solitarius	Solitary vireo	SR	U
Vireo olivaceus	Red-eyed vireo	SR	R
Vireo gilvus	Warbling vireo	SR	C
Vermivora celata	Orange-crowned warbler	SR	C
Vermivora ruficapilla	Nashville warbler	SR	U
Dendroica petechia	Yellow warbler	SR	C
Dendroica coronata	Yellow-rumped warbler	R	C
Dendroica nigrescens	Black-throated gray warbler	SR	U
Dendroica townsendi	Townsend's warbler	WV	U
Dendroica occidentalis	Hermit warbler	SR	U
Oporornis tolmiei	MacGillivray's warbler	SR	C
Geothlypis trichas	Common yellowthroat	SR	C
Spinus tristis	American goldfinch	R	C
Spinus psaltria	Lesser goldfinch	R	U
Pipilo erythrophthalmus	Rufous-sided towhee	R	VC
Passerculus sandwichensis	Savannah sparrow	R	VC
Pooecetes gramineus	Vesper sparrow	SR	U
Junco hyemalis	Dark-eyed junco	R	VC
Spizella passerina	Chipping sparrow	SR	U
Zonotrichia querula	Harris' sparrow	WV	O
Zonotrichia leucophrys	White-crowned sparrow	WV	VC
Zonotrichia atricapilla	Golden-crowned sparrow	WV	VC
Zonotrichia albicollis	White-throated sparrow	WV	R

Table B2 (Concluded)

Scientific Name	Common Name	Status	Abundance
Passerella iliaca	Fox sparrow	R	C
Melospiza lincolnii	Lincoln's sparrow	SR	R
Melospiza melodia	Song sparrow	R	VC
Calcarius lapponicus	Lapland longspur	WV	O
Plectrophenax nivalis	Snow bunting	WV	O

Table B3

Amphibians and Reptiles That Occur
in Northwestern Oregon and Southwestern Washington*

Common Name	Scientific Name
Pacific giant salamander	*Dicamptodon ensatus*
Olympic salamander	*Rhyacotriton olympicus*
Northwestern salamander	*Ambystoma gracile*
Long-toed salamander	*Ambystoma macrodactylum*
Rough-skinned newt	*Taricha granulosa*
Dunn's salamander	*Plethodon dunni*
Western red-backed salamander	*Plethodon vehiculum*
Oregon salamander	*Ensatina eschscholtzi*
Tailed frog	*Ascaphus truei*
Pacific tree frog	*Hyla regilla*
Western toad	*Bufo boreas*
Red-legged frog	*Rana aurora*
Spotted frog	*Rana pretiosa*
Painted turtle	*Chrysemys picta*
Western pond turtle	*Clemmys marmorata*
Northern alligator lizard	*Gerrhonotus coeruleus*
Northwestern garter snake	*Thamnophis ordinoides*
Red-spotted garter snake	*Thamnophis sirtalis concinnus*
Rubber boa	*Charina bottae*

*Compiled from notes from Storm (unpublished notes), and from Slater (1963*b*, 1964*b*). Nomenclature from Stebbins (1966).

Appendix C

ANNOTATED BIBLIOGRAPHY

Appendix C

ANNOTATED BIBLIOGRAPHY

Alcorn, G. D. 1971. Checklist: birds of the state of Washington (Revision of Occasional Papers No. 17). Univ. of Puget Sound, Dept. of Biol., Occas. Papers No. 41. pp. 414-473.

This paper briefly describes the life zones of Washington, including the major bird species that occupy the life zones. A listing of the species of birds for Washington is provided, with brief indications of their distribution periods or residence, nesting habitat, and average number of eggs per clutch.

Anderson, O. I. and J. R. Slater. 1941. Life zone distribution of the Oregon reptiles. Univ. of Puget Sound, Dept. of Biol., Occas. Papers No. 15. pp. 109-119.

Records of reptiles found in literature and reptile specimens in the College of Puget Sound collection were plotted according to Bailey's life zones of Oregon.

Anderson, S. H. 1970. The avifaunal composition of Oregon white oak stands. Condor 72(4):417-423.

This paper presents an analysis of the composition and changes in the avifauna of forests dominated by Oregon white oak from October 1967 to December 1968. Data from observations of avifauna were analyzed on the basis of feeding stations and foraging patterns instead of species. Timber drilling and timber searching species comprised a constant portion of the avifauna throughout the year as they were

mostly resident species. Ground-seed-eating species populations were most numerous during late spring and early summer when migratory species utilized the white oaks. Ground predator abundance changed only with the arrival and departure of turkey vultures. Diversity of avifauna in Oregon white oak stands is higher than diversity reported for other forest communities. Species diversity was highest in early summer and lowest in late summer. Diversity increased from a low of 2.46 in late summer through fall, winter, and spring until it reached the high of 3.13 in early summer. A sharp increase in species diversity index in late spring was accounted for by the arrival of migratory breeding species.

Anderson, S. H. 1972. Seasonal variations in forest birds of western Oregon. Northwest Sci. 46(3):184-206.

Seasonal changes in bird species composition, diversity, and ecological structure were characterized in vegetative types dominated by oak, fir, and hemlock. Food supply, nesting material, climate, and cover sites were factors that contributed to changing avifaunal composition and activity. Most common single-species flocks of birds observed in winter were Oregon juncos, ruby-crowned kinglets, golden-crowned kinglets, and common bushtits. Mixed-species flocks included chickadees, nuthatches, creepers, and woodpeckers. In spring, the total numbers of individuals decreased (even though migratory breeding species arrived) as birds established territories. In late spring, summer residents comprised 51 to 55 percent of all individuals in the conifers and 33 percent in the oaks. Winter species occurred in the oaks, while only residents inhabited conifers in winter. Bird species diversity was highest in oak stands, followed in descending order by hemlock and fir communities.

Bertrand, G. A. and J. M. Scott. 1971. Checklist of the birds of Oregon. Oreg. St. Univ. Bookstores, Corvallis. 17 pp.

This publication provides a listing of all birds known to occur in Oregon and indicates residential status and abundance of birds by region of the state.

Breckon, G. J. and M. G. Barbour. 1974. Review of North American Pacific coast beach vegetation. Madroño 22:333-360.

The authors present a summary, mainly through a literature review, of beach vegetation and its phytogeography along the Pacific Coast between Point Barrow, Alaska, and the southern tip of Baja California. The survey includes vegetation of the beach strand but not species of adjacent habitats such as dunes, marshes, or intertidal areas unless those species are also characteristic of the beach vegetation. The authors noted that significant contributions to the vegetation are made by introduced plants such as *Ammophila arenaria* and *Cakile* spp. The climate and vegetation typical of selected stations along the coast are briefly discussed. Examples of species representing nine phytogeographic groupings of 46 characteristic species are presented and discussed in relation to their latitudinal distribution. Ecofloristic groupings and their similarities to each other are presented and discussed, along with autecological observations of representative characteristic species where this information is available. A rather extensive bibliography is also presented.

Chamberlain, J. L. 1959. Gulf Coast marsh vegetation as food of wintering waterfowl. J. Wildl. Manage. 23(1):97-102.

Seventeen species of ducks and geese totaling 1251 individuals were analyzed for gizzard contents. Seeds of *Cladium, Scripus,* and *Eleocharis,* all members of the family Cyperaceae, were most frequently taken. The family

Gramineae was second in importance. A difference in foods taken in a freshwater marsh as compared with a saltwater marsh implied to the authors that food habits are influenced by availability.

Clair, E. W., H. M. Scott, and D. E. Sanford. 1971. The potential impact of severe water fluctuations on wildlife resources of the lower Columbia River. Oreg. St. Game Comm. Spec. Rep. 18 pp.

Fluctuating water levels caused by "power peaking" may have detrimental effects on wildlife populations. Waterfowl nesting would be most seriously affected between 1 March and 15 May. Furbearers that rear young in dens in banks would be harmed by water levels that fluctuate in March and April, causing openings to dens to be exposed or causing flooding of dens. Birds that typically build nests on or close to the edge of the water would be affected by fluctuating water levels. Fluctuations could also impair access of hunters to and from sloughs and channels in the Columbia River.

Daubenmire, R. 1962. Vegetation of the state of Washington: a bibliography. Northwest Sci. 36(2):50-54.

A bibliography of published articles is presented, pertaining to Washington in particular but relevant to contiguous portions of British Columbia, Idaho, and Oregon. The literature cited contains articles covering alpine vegetation, coniferous forests, desert-steppes, epiphytes, marshes, bogs, and related ecological topics.

DeSelm, H. R. and R. E. Shanks. 1967. Vegetation and floristic changes on a portion of White Oak Lake bed. Ecology 48(3):419-425.

"ABSTRACT. White Oak Lake, Oak Ridge, Tennessee, was used as a dilution basin for radioactive and chemical wastes from 1943 to 1955, when it was drained. From 1956 to 1960 the vegetation on 3

acres of the dry lake bed was identified, mapped, and clip sampled. The plant collections revealed rapid invasion and succession by many species. Cover was almost complete the second year. The initial forb cover, made up chiefly of *Polygonum*, subsequently declined from 73 percent to 20 percent. *Juncus* and *Carex*, which provided the major cover in 1957 and 1959, respectively, had declined by 1960. Thickets and open woody stands of *Salix* developed in the first 2 years after the lake was drained. Only a slight correlation was found between the vegetation patterns and the isopleths of known physical or chemical soil characteristics."

The authors noted that *Juncus* and *Carex* stands were replaced by *Eulalia*, open woody vegetation (*Salix, Amorpha,* and *Cornus*), or thickets (mainly *Salix* along the creek where water is most available) as succession proceeded.

Donohoe, R. W. 1966. Muskrat reproduction in areas of controlled and uncontrolled water-level units. J. Wildl. Manage. 30(2):320-326.

Populations of muskrats on diked and undiked marshlands were studied to determine parameters of reproduction, sex, age, and weight and to determine importance of dredged material banks on productivity and population density. There was a higher proportion of juveniles from the controlled area, and average weights of juveniles from control habitat were significantly heavier than the juveniles from the undiked habitat. Numbers of muskrat houses were higher in the diked habitat. Dredged material banks provided denning habitat for greater densities of muskrats. There was no difference between embryo counts in diked and undiked habitats.

Dwyer, T. J. 1970. Waterfowl breeding habitat in agricultural and non-agricultural land in Manitoba. J. Wildl. Manage: 34(1):130-136.

Thirty-three potholes were examined to determine habitat characteristics for waterfowl and to contrast waterfowl use and production on agricultural and nonagricultural land in Manitoba. Mallard and blue-winged teal pairs used forest-rimmed potholes more than nonforested potholes in agricultural land. Lesser scaup, canvasback, and redhead used potholes in agricultural land more. The presence of tall, woody vegetation on the margin of potholes limited use by diver ducks to the larger (7-acre) potholes. Dabbler ducks appeared to prefer forest-rimmed potholes because these provided superior resting cover.

Evans, J. 1970. About nutria and their control. U.S. Bur. Sport Fish. & Wildl. Res. Pub. No. 86. 65 pp.

This paper provides information on the history, biology, behavior, and control of nutria. Nutria have both a beneficial and a pest status. Sale of nutria fur and meat in Texas and Louisiana is a million-dollar-plus industry in some years. Nutria were successfully introduced into the United States from South America in the 1930s. Gulf Coast nutria average 4.5 young per litter with gestation lasting 130 days. Nutria can cause damage to agricultural crops and earth dams and levees. The best method for controlling nutria is the use of zinc phosphide on carrot baits. Other methods of control include shooting, kill-trapping, and live trapping.

Franklin J. F. and N. E. West. 1965. Plant communities of Oregon: a bibliography. Northwest Sci. 39(2):73-83.

This bibliography lists references that provide information on composition, ecology, or distribution of plant communities.

References limited to the autecology of individual species are not included. Certain unpublished theses are also included.

Gabrielson, I. N. and S. G. Jewett. 1970. Birds of the Pacific Northwest with special reference to Oregon (formerly titled: Birds of Oregon). Dover Publications, New York. 650 pp.

This report provides descriptions of plumages, distribution, and historical documentations of occurrences of the birds of Oregon prior to 1940.

Goertz, J. W. 1964. Habitats of three Oregon voles. Ecology 45(4): 846-848.

This is a report on a study conducted in western Oregon to determine the habitat preferences of the Oregon vole, Townsend's vole, and the gray-tailed vole. One hundred thirty-nine Oregon voles were collected from Douglas fir forests in the Coast Range. Oregon voles preferred cut-over areas, woodlands, glades, forests, south slopes, and riparian habitats in decending order. Most of the 56 Townsend's voles collected were taken from Coast Range and Willamette Valley riparian habitat. *Juncus* and velvetgrass cuttings were found in Townsend's vole runways. In most cases, this vole was associated with dense grass and sedge. Most of the 430 gray-tailed voles came from cropland.

Gordon, K. 1966. Mammals and the influence of the Columbia River gorge on their distribution. Northwest Sci. 40(4):142-146.

Of 80 species of mammals found near the Columbia River, 68 are found on both sides, 12 are found on only one side. The gorge provides a route through which animals may pass the barrier of the Cascade Mountains. Explanations of how mammals crossed the gorge are subject to speculation. Some mammals may have crossed from northward during the most recent ice age. Other methods of crossing the

Columbia include swimming, rafting, crossing ice bridges, and taking advantage of shifting channels.

Hall, E. R. and K. R. Kelson. 1959. The mammals of North America. Vols. I and II. The Ronald Press Co., New York. 1083 pp. and 79 index pages.

This is a taxonomic publication that provides descriptions of morphology and of distributions of the mammal species of North America.

Harris, S. W. and W. H. Marshall. 1960. Germination and planting experiments on soft-stem and hard-stem bulrush. J. Wild. Manage. 24(2):134-139.

"SUMMARY. Five storage and three germination conditions were on three lots of soft-stem bulrush and one lot of hard-stem bulrush seed. No appreciable germination was obtained after 3, 6 and 7 months' storage in any of the tests. Manipulation of illumination and moisture during storage increased germination percentages somewhat. Seed stored under natural water all winter and germinated under natural conditions had the highest germination percentages. Soft-stemmed bulrush seed which had been fed to a mallard duck and recovered from the droppings was reduced in its germination compared to seed which had not been fed. Five lots of seed were planted in the spring and no seedlings became established. In contrast, all of four plantings made in the fall after the growing season developed heavy stands of seedlings the following spring and summer. Two methods of combining drawdown operations and bulrush seeding are suggested."

Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. of Wash. Press, Seattle. 730 pp.

This is essentially a condensation of a five-volume work by Hitchcock et al. and was designed to present the most useful information in the least space so that the book can be used as a field manual.

Holmes, R. T. 1972. Ecological factors influencing the breeding season schedule of Western sandpipers (*Calidris mauri*) in subarctic Alaska. Amer. Midl. Natur. 87(2):472-491.

The breeding system ecology of the western sandpiper was studied on the Yukon-Kuskokwim Delta in western Alaska. Western sandpipers migrate in autumn, mainly along the Pacific Coast of North America from southeastern Alaska to Baja California. Western sandpipers winter on the Pacific Coast from northern California to Peru and on the southern Atlantic coast, and along the Gulf of Mexico, south to Central America and northern South America. Western sandpipers arrived on the breeding areas after tundra was free of snow, between 12 and 20 May. Peaks in hatching of clutches occurred by mid-June. Adults and juveniles form separate flocks after juveniles attain flight. By mid-July, numbers of adult sandpipers decreased in the breeding area and appeared along river channels and along the coast. By the end of July, all adult westerns apparently had migrated south. Most juveniles migrated south by the first week in August. Breeding occurs as early as possible and varies with the time of snow melt.

Only one clutch of eggs is laid. There is no attempt to produce a second clutch after successfully completing the first. Adults leave the nesting habitat soon after the young fledge and then depart southward by mid-July; the young follow 2 to 3 weeks later. Clutches hatch in June, coinciding with the emergence of adult insects on the

tundra surface. Ecological factors most likely to affect breeding success are length of season, weather, predators, and food supply. Insect larvae are abundant in May and June but decrease by mid-July. Sandpipers then move to feeding sites near the Bering Sea but utilize mostly insects. Western sandpipers may have exploited their food source by mid to late summer, necessitating departure by late July or early August.

Ingles, L. B. 1965. Mammals of the Pacific states: California, Oregon, and Washington. Stanford Univ. Press, Stanford, Calif. 506 pp.

This study provides taxonomic keys and descriptions of identifying characteristics of the mammals of California, Oregon, and Washington. In addition, it describes status, life histories, and histories of mammals of the Pacific states.

Jefferson, C. A. 1974. Plant communities and succession in Oregon coastal salt marshes. Unpub. Ph.D. Dissertation, Oreg. St. Univ. 192 pp.

The purpose of the study was to determine species composition, successional relationships, community structure, and plant distributions in estuarine salt marshes in Oregon. The author identified three major patterns of plant succession: two based on sand or silt substrates and the third found in areas influenced by fresh water runoff. The author found *Carex lyngbyei* to be an intermediate in all modes of succession, being replaced by *Deschampsia cespitosa* and eventually by other more xeric grasses or maturing into an *Alnus-Salix* swamp or forest.

Plant distributions were found to be related to elevation, whereas the phenology was related to tidal exposure, salinity, and water table depth.

The author concluded that the Oregon coastal salt marshes are a transition between temperate and subarctic marshes and

are more similar in physiognomy to boreal salt marshes in Scandinavia than to any other region of the Atlantic and Pacific coasts.

D. cespitosa and *C. lyngbyei* are the most important species in raising marsh levels. *D. cespitosa* forms tussocks by trapping sediments and raises the ground surface between 10 cm and 25 cm. The average rate of sediment accretion in Oregon salt marshes varies between 0.0 cm and 2.0cm/yr.

Johannessen, C. L. 1964. Marshes prograding in Oregon: aerial photographs. Science 146:1575-1578.

The author presents evidence that circular colonies of coastal wetland vegetation found on mud flats are indicators that the marsh is expanding rapidly. The clumps usually spread laterally by tillering and trapping sediments, thereby slowly increasing the ground surface elevation. As the ground surface becomes elevated, ecological conditions change, and one species is replaced by another that is better adapted to the new conditions. The dominant species comprising these colonies found at low to high elevation within the marsh are sea arrow grass (*Triglochin maritima*), marsh bulrush (*Scirpus robusta*), Lyngby's sedge (*Carex lyngbyei*), and tufted hairgrass (*Deschampsia cespitosa*).

Keefe, C. W. 1972. Marsh production: a summary of the literature. Univ. of Md., Contr. Marine Sci. 16:163-181.

The author presents a review of studies of freshwater and saltwater marsh production. Representative production estimates are presented for several species from different geographical regions. Reasons, including the abundance of water, are discussed for the unusually high production of these communities when compared with terrestrial communities and to phytoplankton. Nutrient contents of

selected marsh species are also presented, as well as a discussion of the role of marsh plants as food for consumers. A fairly extensive bibliography serves as the basis for this review.

Keith, B. and R. Stanislawski. 1960. Stomach contents and weights of some flightless adult pintails. J. Wildl. Manage. 24(1):95-96.

Approximately 150 pintails collected at Pel Lake, Saskatchewan, were weighed and examined for gizzard contents. Seeds and fruits of Alkali bulrush (*Scirpus paludosus*), sago pondweed (*Potamogeton pectinatus*), and hardstem bulrush (*Scirpus acutus*) comprised over 98 percent of identifiable plant material. Insects and other invertebrates comprised less than 5 percent of the total volume of organic material.

Kelley, J. M., G. M. VanDyne, and W. F. Harris. 1974. Comparison of three methods of assessing grassland productivity and biomass dynamics. Amer. Midl. Natur. 92(2):357-369.

"ABSTRACT. Data from three different grassland communities were analyzed to evaluate the effectiveness of three methods of estimating net production of plant communities dominated by various mixtures of grasses, forbs and shrubs. The methods were: (1) peak standing crop, (2) summation of peak biomass for each species, and (3) incremental summation of biomass increases. Each method was applied to living biomass, standing dead biomass and litter. Comparison of the methods indicates that each has its application, but in most cases summation of positive biomass increases gave maximum estimates of community net productivity."

The Wiegert-Evans method utilizes a summation of biomass increases and incorporates a knowledge of the instantaneous

rate of litter decay. The grasslands were sampled at intervals to include as closely as possible the phenological events of flowering, seed set, seed head shattering, and growing season termination. Estimates derived from peak standing crop measurements were always lower (12-30 percent) than the other two methods. However, a weakness of the summation method is that more samples are required to reduce sample variance.

The authors recommend the peak standing crop method where only one sample period is dictated or when the communities are composed of phenologically similar taxa. Where each species of the community reaches only one peak during the growing season, the species peak summation method is recommended. Where multiple peaks are expected, the incremental summation of biomass increases provide for their detection.

The authors state that the peak standing crop method is least affected by a reduction in frequency of sampling: sampling at two-week intervals averaged 2 percent less than sampling at one-week intervals, while sampling at four-week intervals averaged 19 percent less. Summation of species peaks on two- and four-week intervals, respectively, detected an average of 10 percent and 30 percent less net productivity as compared to weekly sampling, while the summation of positive biomass averaged 34 percent to 50 percent less.

The authors suggest sampling at two-week intervals for the peak standing crop method or summation of species peak method. One-week intervals may be necessary in order to realize the improvement in net production estimation offered by the summation of positive biomass increases. Summation by species peaks may be an acceptable method where the communities are strongly dominated by a single species.

Kricher, J. C. 1972. Bird species diversity: the effect of species richness and equitability on the diversity index. Ecology 53(2):278-282.

The Shannon-Weaver formula for diversity was examined to determine the contribution of its component parts to bird species diversity (BSD). BSD was calculated from observations taken of three different seral communities during winter 1968-1969 and during spring and summer 1969. Species diversity was highest during summer. Species richness accounted for many differences in bird species diversity between seral stages. Equitability was found to be lowest and to have its greatest influence on the youngest seral state. Equitability was higher and more constant in older seral stages. Territoriality was thought to account for higher equitabilities in summer.

Kricher, J. C. 1973. Summer bird species diversity in relation to secondary succession on the New Jersey piedmont. Amer. Midl. Natur. 89(1):121-137.

Bird species diversity (BSD) of three seral states of old-field succession on the New Jersey piedmont was estimated in an attempt to correlate BSD with the age of the seral stage. Bird species diversity increased with the age of the seral stage. In both 1968 and 1969, oak forest had the highest BSD followed by cedar field and herbaceous field. BSD increased most rapidly in the earlier stages of succession. Highest variability in BSD occurred in the youngest seral stage (herbaceous field) because many birds that used this habitat were nonnesters and their occurrence was variable.

Kuhn, L. W. and P. E. Peloquin. 1974. Oregon's nutria problem. Proc. Sixth Vertebr. Pest Conf. pp. 101-105.

Nutria (*Myocastor coypus*) were introduced into Oregon during the period from 1930 to the 1950s by fur farmers. Nutria

that either escaped or were released from fur farms provided the initial feral populations in Oregon. Peak sexual maturity is attained in 6 to 9 months for males and in 4 to 9 months for females. Gestation requires 130-132 days; peak months of birth are January, March, and May. Nutria commonly depredate many agricultural crops in the Willamette Valley. Their burrow systems cause damage to stream banks, field borders, and farm ponds. Zinc phosphide on carrot baits is the most effective method for controlling excessive populations of feral nutria in Oregon. Freezing weather in December 1972 caused heavy losses, and present populations are considered to be at a moderately low level.

Kumler, M. L. 1969. Plant succession on the sand dunes of the Oregon Coast. Ecology 50(4):695-704.

"ABSTRACT. Parabolic sand dune succession was studied on 48 plots within a 150-mile section of the Oregon coastline. The sand dune communities were described and related to their successional sequence. Both plot and plotless techniques were used to obtain data for frequency, density, cover, and dominance. Successional stages of upland areas of coastal sand dune were represented by nine communities of plants which ranged from scattered, pioneer, herbaceous plants on barren, shifting sand to the near-climax, physical-biological system — the dune forest. The stands included a pioneer stage consisting of herbaceous plants which appeared early on the unstabilized dunes. A second community made up of many annual and some perennial herbaceous plants emerged on protected, lee slopes along the edges of dunes supporting pioneer communities. The third community located on somewhat stabilized sand was produced by a merging of some of the more hardy herbaceous plants from the second community, and the

appearance of some shrubs also found in the following community. The fourth community was located on sites of stabilized sand and consisted mainly of shrubs. The remaining five communities, containing trees and shrubs on stabilized sand, were *Pinus contorta*-shrub; *Pinus-Picea*-shrub; *Picea sitchensis*-shrub; *Picea-Tsuga*-shrub; and *Tsuga heterophylla*-shrub. Many of the dominant species gradually declined as the succession proceeded from one community to another and other dominants appeared. The most notable exception to this progression occurred in the herbaceous community along the lee edges of the initial dunes, where the vegetational changes were much more abrupt."

On unstabilized dunes, the dominant pioneer plants were these: *Glehnia leiocarpa, Carex macrocephala, Poa macrantha, Lupinus littoralis,* and *Polygonum paronychia*. On the lee edges of the initial dune areas, a second community was found. Dominant annual species included *Achillea millefolium, Hypochaeris radicata, Anaphalis margaritacea, Cerastium holosteoides, Festuca rubra, Poa confinis, Holcus lanatus, Rumex acetosella,* and *Aira praecox*. This community grades into a shrub community characterized by *Gautheria shallon, Vaccinium ovatum, Arctostaphylos uva-ursi,* and *Pteridium aquilinum,* and sometimes, *Arctostaphylos columbiana*.

The main tree species found in the forested communities were *Pinus contorta, Picea sitchensis,* and *Tsuga heterophylla*.

Lomnicki, A., E. Bandola, and K. Jankowska. 1968. Modification of the Wiegert-Evans method for estimation of net primary production. Ecology 49(1):147-149.

"ABSTRACT. The assumptions on which the Wiegert-Evans (1964) paired plots estimation method of net primary

production are based are discussed. An approach is proposed which does not involve the estimation of the disappearance rate of dead plant material and the standing crop of dead vegetation and which uses only measurements of growth of green plant material and of dead plant material. The Wiegert-Evans method and the modification were compared on a grassland community in Poland. There were no significant differences in the results, but the modified method proved simpler to use."

A maximum time interal between sampling periods of one month was recommended for this community to avoid errors due to the disappearance of dead material that has died during the time interval.

Marshall, D. B. 1969. Endangered plants and animals of Oregon: Vol. III, Birds. Oreg. St. Univ. Agr. Exp. Sta. Spec. Rep. No. 278. 23 pp.

This study describes the status of the birds of Oregon that are on the national rare or endangered lists. It also establishes a list of birds that are rare or endangered within the state but may not necessarily be so classified on a national basis.

Masson, W. V. and R. U. Mace. 1965. Upland game birds. Oreg. St. Game Comm. Wildl. Bul. 5. 44 pp.

This publication lists the upland game birds that occur in Oregon and provides information on their life histories and distributions.

McDonald, M. E. 1955. Cause and effects of a die-off of emergent vegetation. J. Wildl. Manage. 19(1):24-35.

An abrupt die-off of marsh vegetation adjoining Lake Erie occurred in the winters of 1945-46 and 1951-52. These die-offs were associated with abnormally high water levels and involved *Scirpus*, *Typha*, *Carex*, and *Phragmites*. The immediate effects of the die-off were an increase in the amount of submerged waterfowl food plants such as *Sagittaria*, *Valisneria*, and *Potamogeton*, the break-up of large blocks of reed marsh, and a reduction in muskrat habitat. Later effects included formation of floating islands of vegetation. As the water receded, new patches of *Scirpus*, *Lophotocarpus*, and *Sagittaria* were established, and relict stands of *Typha* showed renewed vigor.

McLaughlin, E. G. 1974. Autecological studies of three species of *Callitriche* native in California. Ecol. Monogr. 44:1-16.

The author studied three species under field and laboratory conditions, subjecting them to varying environmental conditions (photoperiod, temperature) within the laboratory. *Callitriche palustris* occurs over a wide geographical range and in diverse habitats from sea level to over 2500 m. The other two species are more restricted. *C. palustris* occurs in lakes, in streams, on mud, and in wave-beaten and sheltered positions; circumboreally, it occurs south to 35°N. latitude in both New and Old Worlds. This species is thought to be apomictic in nature, thus tending to preserve the highly or widely tolerant genotypes this species has evolved.

Oregon Cooperative Wildlife Research Unit. 1974. Annual rep., Columbia River wildlife study. 82 pp.

This report presents the results of the first year of a 2-year project to determine species and relative abundances of birds, mammals, amphibians, and reptiles in the riparian habitat along the Columbia River from the mouth to McNary Dam. Vegetative surveys and censusing of birds, mammals, amphibians, and reptiles were conducted from fall 1973 to 1974. Sixty-four species of mammals were identified; *Peromyscus maniculatus* and *Sorex vagrans* were most abundant. The report provided a list of 204 species of birds and indicated the status of colonial birds nesting along the Columbia River. Thirty species of amphibians and reptiles were identified. A final report with more complete analysis of data will be prepared in late 1975.

Pearson, J. P. and B. J. Verts. 1970. Abundance and distribution of harbor seals and northern sea lions in Oregon. Murrelet 51(1):1-5.

Periodic surveys of habitats were conducted from July 1967 to June 1968 along the Oregon coast to determine the abundance and distribution of northern sea lions and harbor seals. The largest concentration of seals was observed in the vicinity of the mouth of Coos Bay in May 1968, when 185 seals were counted. There were probably fewer than 500 harbor seals along the coast of Oregon in 1968. The population of northern sea lions was believed to be 1078 in 1968. Populations of harbor seals and northern sea lions have apparently declined since 1925 as a result of control measures and harassment.

Peloquin, P. E. 1969. Growth and reproduction of the feral nutria *Myocastor coypus* (Molina) near Corvallis, Oregon. Master's Thesis, Oreg. St. Univ. 55 pp.

Six hundred and forty nutria were examined between 1 August 1965 and 30 May 1967 to determine parameters of growth and reproduction. Mean weight at birth of ten nutria was 217±40 g. Increments in weights were highest during the first 5 months after birth, averaging 0.9 pounds per month. The average weight of nutria assumed to be older than 10 months was 13.1 pounds (7.0 to 24.0, n = 134) for males, and 11.6 pounds (10.5 to 25.0, n = 127) for females. Male nutria attained sexual maturity at ages between 6 and 9 months; females were sexually mature in 4 to 9 months after birth. Major peaks in births occurred in January, March, and May, with a lesser peak occurring in October. Five pregnant females averaged 5.0 (3 to 8) kits per litter. Gestation averaged 130 days. Females may have had more than two litters per year.

Phillips, E. Q. 1959. Methods of vegetation study. Henry Holt and Co., New York. 107 pp.

The author presents brief descriptions of several different systems of vegetation study. American, European, and British systems and concepts are included.

Redfield, A. C. 1972. Development of a New England salt marsh. Ecol. Monogr. 42(2):201-237.

"ABSTRACT. The salt marsh at Barnstable, Massachusetts, occupies an embayment into which it has spread during the past 4000 years. It exhibits all stages of development from the seeding of bare sand flats through the development of intertidal marsh to the formation of mature high marsh underlain by peat deposits more than 20 ft. deep. Observations and measurements of the stages of its formation are presented. The geomorphology of the marsh is considered in relation to the factors which have influenced its development,

i.e., the ability of halophytes to grow at limited tide levels, the tidal regime, the processes of sedimentation, and the contemporary rise in sea level. The rates at which the early stage of development takes place have been determined by observations during a period of 12 years and the time sequence of later stages by radiocarbon analyses."

The author documented the rate of expansion of small islands or clumps of *Spartina alterniflora* at 2.4 ft./yr. over a 10-year period. Hence, opposite margins are spreading (by rhizomes) at the rate of 1.2 ft./yr. The rate of vertical accretion of the intertidal marsh averaged 0.06 ft./yr.

Shugart, H. H., Jr. and D. James. 1973. Ecological succession of breeding bird populations in northwestern Arkansas. Auk 90(1):62-77.

Species and densities of birds in seral stages of upland succession in Arkansas in 1967 were determined from 10 study plots. Upland succession in the region of the study involved three general states: fields dominated by grasses and forbs, fields dominated by shrubs and shade intolerant trees, and forests. Bird population densities and species diversity tended to increase with the ecological age of the site.

Shure, D. J. 1971. Tidal flooding dynamics: its influence on small mammals in barrier beach marshes. Amer. Midl. Natur. 85(1):36-44.

The effects of tidal flooding on small mammal populations of communities of a barrier beach in New Jersey were investigated. *Microtus pennyslvanicus* was captured more frequently in drier sites densely covered with *Spartina patens* as compared with the wetter *Spartina alterniflora* habitats. Hummocks vegetated by *S. patens* were above tidal influence and occupied by *Microtus*. Only *Microtus*

was associated with herbaceous vegetation of salt-marsh communities. *Zapus hudsonicus* occurred in shrub-dominated brackish marsh while *Microtus* occurred in herbaceously vegetated brackish marsh. *Peromyscus leucopus* dominated savannah areas with accumulations of dead shrub or red cedar debris.

Slater, J. R. 1963*a*. A key to the adult reptiles of Washington state. Univ. of Puget Sound, Dept. of Biol., Occas. Papers No. 23. pp. 209-211.

This report provides a key to the reptiles of Washington.

Slater, J. R. 1963*b*. Distribution of Washington reptiles. Univ. of Puget Sound, Dept. of Biol., Occas. Papers No. 24. pp. 212-233.

This paper provides a listing of the species of reptiles that occur in each county in Washington. An analysis of the distribution of reptiles by life zone is provided.

Slater, J. R. 1964*a*. A key to the adult amphibians of Washington state. Univ. of Puget Sound, Dept. of Biol., Occas. Papers No. 25. pp. 235-236.

This publication provides a key to the amphibians of Washington.

Slater J. R. 1964*b*. County records of amphibians for Washington. Univ. of Puget Sound, Dept of Biol., Occas. Papers No. 26. pp. 237-242.

This paper provides records of occurrence by species of amphibians in counties of Washington. Changes in information about the distribution of amphibians in Washington since 1955 are discussed.

Storm, R. H. 1966. Amphibians and reptiles. Northwest Sci. 40(4): 138-141.

In considering the effect of the Columbia River on distributions of amphibians and reptiles, several general patterns were observed. First, the Columbia River provides

no apparent barrier effect on the distribution of amphibians and reptiles west of the Cascades. Some 14 amphibian and 15 reptile species show a present distribution on both sides of the Columbia largely west of the Cascades. Second, a partial barrier effect by the river limits the distribution of one amphibian and seven reptiles. These animals are generally widely distributed in Oregon but only sparsely distributed in Washington. Finally, there are a few forms to which the Columbia apparently has been a complete barrier.

Suring, L. H. 1975. Habitat use and activity patterns of the Columbia white-tailed deer along the lower Columbia River. Master's Thesis, Oreg. St. Univ. 59 pp.

A study of Columbian white-tailed deer, including life history, population dynamics, and ecological relationships, was conducted on the Columbian White-Tailed Deer National Wildlife Refuge between 1972 and 1973. In winter between 200 and 230 deer were estimated to have been on the study area. Deer were observed most often in plant communities that provided both food and cover. Grazing occurred more frequently in summer than in winter. Deer avoided close association with cattle and used those areas where cattle densities were lowest or where cattle were not present.

Tramer, E. J. 1969. Bird species diversity: components of Shannon's formula. Ecology 50(5):927-929.

Shannon's formula was calculated for 267 breeding bird censuses. The components of the formula, species richness and relative abundance, were evaluated to determine which contributed most to diversity patterns. The regression of H' against $\log_2 S$ showed that changes in diversity were closely related to species richness. Factors that regulate species diversity do so by determining the number of species that can coexist in a given habitat.

U.S. Army Engineer District, Portland, Oreg. 1974. Columbia and lower Willamette River, maintenance and completion of the 40-foot navigation channel downstream of Vancouver, Washington and Portland, Oregon. Draft Environmental Impact Statement, Sec. 2.5.

Amphibians occurring in the lower Columbia River region include these: red-legged, spotted, tree, bull, and tailed frogs; western toad; northwestern, long-toed, Pacific giant, olympic, Dunn's, western red-backed, ensatina, and clouded salamanders; and the rough-skinned newt. Reptilian species include the painted turtle, northern alligator lizard, rubber boa, racer, gopher, common garter, and northwestern garter snakes. Waterfowl winter in the area, and mallards, cinnamon teal, blue-winged teal, wood duck, and Canada geese nest in small numbers. Small mammals found on the Columbia River flood plain include otter, beaver, mink, raccoon, nutria, squirrels, rabbits, foxes, moles, shrews, mice, rats, bats, black-tailed deer, Columbian white-tailed deer, bear, and elk. The report notes, "Rats are prevalent in the lower Columbia, particularly in the vicinity of Astoria."

U.S. Department of the Interior. 1973. Threatened wildlife of the United States. U.S. Fish & Wildl. Serv., U.S. Bur. of Sport Fish. and Wildl., U.S. Government Printing Office, Washington, D.C. 287 pp.

The "red book" provides a listing of the fauna of the United States that are threatened with extinction or classified as peripheral or status undetermined. It discusses distinguishing characteristics, present and former distributions, estimated numbers, status, and the life history of each species.

U.S. Department of the Interior. 1974. United States list of endangered fauna. U.S. Fish & Wildl. Serv. 22 pp.

This presents the official United States list of endangered species of animals of the world.

Verts, B. J. 1971. Keys to the mammals of Oregon. Oreg. St. Univ. *Bookstores, Corvallis. 82 pp.*

This is a taxonomic publication providing keys and descriptions of distributions of the mammals of Oregon.

Walker, B. H. and C. F. Wehrhahn. 1971. Relationships between derived vegetation gradients and measured environmental variables in Saskatchewan wetlands. *Ecology* 52(1):85-95.

"ABSTRACT. Thirty-four relatively undisturbed stands of vegetation in shallow marsh, non- to slightly saline wetlands in south-central Saskatchewan were examined with respect to environmental influence on species distribution. Four environmental gradients account for the bulk of variation in the vegetation. They are, in decreasing order of importance, disturbance (despite the fact that all stands chosen are relatively undisturbed), available nutrients, water regime, and salinity. The greatest variation in the data from these stands as a whole is in their salinity, but this is not reflected in the vegetation. The correlation between water regime and available nutrients is negative. A number of other factors show minor correlations with the vegetation and with each other. The method of application of principal components analysis used in this study was a valuable aid in the interpretation of the data. It provides estimates of the proportions of (1) the variance associated with each principal component and (2) the total variation in the vegetation data that can be assigned to variation in the environmental measurements."

The method of principal components analysis of the vegetation in the form of adjusted attribute loadings allowed identification of environmental gradients that correlated with species distributions. For example, the first principal component

indicated a disturbance gradient with high adjusted loadings (correlation coefficients) for *Eleocharis palustris, Glyceria grandis, Alopecurus aequalis, Beckmannia syzigachne* and *Sium suave*.

Weaver, J. E. 1960. Flood plain vegetation of the central Missouri valley and contacts of woodland with prairie. Ecol. Monogr. 30(1):37-64.

This is a comprehensive description of the vegetative communities that includes the following topics: origin and development of streams and their woody vegetation, contacts of woodland with prairie, the larger bottom lands and their vegetation, development of flood plains, flood plain soils, flood plain forest, extent of flood plain forest, swamps, marshes, coarse grasses of the wetlands, transition to big bluestem prairie, and community life in big bluestem prairie.

The flood plain forest contains several species of willows (*Salix* spp.), cottonwoods (*Populus* sp.), dogwood *Cornus* sp.), and elm (*Ulmus* sp.). Common understory shrubs are indigobush (*Amorpha* sp.), wolfberry (*Symphoricarpos* sp.), and sumac (*Rhus* sp.).

The dominant species of swamps are bulrushes (*Scirpus validus, S. acutus, S. fluviatilis)*, cattail (*Typha* sp.), reed (*Phragmites communis*), and arrowhead (*Sagittaria latifolia*). Marshes have various species of *Carex, Juncus,* and *Eleocharis* as their dominants.

Wiegert, R. G. and F. C. Evans. 1964. Primary production and disappearance of dead vegetation in an old field in southeastern Michigan. Ecology 45(1):49-63.

The authors present a "paired plots" method to estimate net primary productivity that is described in detail. This method involves estimating disappearance rate of

dead plant material, together with data on standing crop of green and dead material. The assumptions made by the authors are these: (1) the rates of disappearance from both plots are equal; (2) the species composition and biomass of the dead material on the two plots are identical; and (3) no addition to the dead material of the second plot is made during the time interval between successive samples. Another underlying assumption is that the disappearance rate of dead material is the same in the absence as in the presence of green vegetation.

Yocom, D. F. 1961. Recent changes in Canada goose populations in geographical areas in Washington. Murrelet 42(1):13-21.

There were many more nesting Canada geese in Washington at the end of the 1953 nesting season than there were prior to the arrival of white men in the Pacific Northwest. Changes in local distributions of resident geese have resulted from drainage of habitats in some places and from creation of habitats in other places resulting from irrigation projects. With the exception of a pair of Canada geese nesting in the Willamette Valley, there were no records of Great Basin Canada geese nesting west of the Cascades prior to 1952.

In accordance with letter from DAEN-RDC. DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

White, C David
Habitat development field investigations, Miller Sands Marsh and Upland Habitat Development Site, Columbia River, Oregon; Appendix C: Inventory and assessment of prepropagation terrestrial resources on dredged material / by C. David White, Donald O. McKay, Alan D. Grant, Woodward-Clyde Consultants, San Diego, California. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
79, [49] p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-77-38, Appendix C)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. DACW57-75-C-0247 (DMRP Work Unit No. 4B05D)
Includes bibliographies.

1. Assessments. 2. Columbia River. 3. Dredged material.

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White, C David
Habitat development field investigations, Miller Sands Marsh and Upland Habitat Development Site, Columbia River, Oregon; Appendix C: Inventory and assessment of prepropagation terrestrial resources on dredged material ... 1978.
(Card 2)

4. Ecology. 5. Field investigations. 6. Miller Sands Island. 7. Terrestrial habitats. I. McKay, Donald O., joint author. II. Grant, Alan D., joint author. III. United States. Army. Corps of Engineers. IV. Woodward-Clyde Consultants. V. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-77-38, Appendix C.
TA7.W34 no.D-77-38 Appendix C